The Department of Defense

DoD Departments:

Department of the Navy

Department of the Air Force

Defense Special Weapons Agency

OSD DDR&E

Office of Secretary of Defense Director Defense Research and Engineering

Special Operations Command

DARPA

Defense Advanced Research Projects Agency

BMDO

Ballistic Missile Defense Organization

CBD

Joint Chemical Biological Defense

PROGRAM SOLICITATION 98.1
CLOSING DATE: 14 JANUARY 1998

FY 1998 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 98.1

Small Business Innovation Research Program

IMPORTANT

The DoD updates its SBIR mailing list annually. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference G) found at the back of this solicitation or complete the electronic form at http://www.teltech.com/sbir/form.html. Failure to send the form annually will result in removal of your name from the mailing list.

If you have questions about the Defense Department's SBIR program, please call the SBIR/STTR Help Desk at (800) 382-4634, or see the DoD SBIR/STTR Home Page, at http://www.acq.osd.mil/sadbu/sbir.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Opening Date: Wed., October 1, 1997
Closing Date: Wed., January 14, 1998

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000

ACQUISITION AND TECHNOLOGY

IMPORTANT NEW FEATURES OF THE DEFENSE DEPARTMENT'S SBIR PROGRAM

This solicitation reflects a number of important changes in the Defense Department's SBIR program that have been implemented over the past two years. The purpose of these changes is (1) to make the program more user-friendly to small firms and (2) to increase commercialization of SBIR research in military and/or private sector markets. The main changes are as follows:

1. **The Department has streamlined the processing of applications under the SBIR "Fast Track," and made other significant improvements in the Fast Track policy.** Under the Fast Track policy, SBIR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to (1) receive interim funding between Phases I and II; (2) be evaluated for Phase II award under a separate, expedited process; and (3) be selected for Phase II award provided they meet or exceed a threshold of "technically sufficient" and have substantially met their Phase I technical goals (and assuming other programmatic factors are met). Consistent with DoD policy, this process should prevent any significant gaps in funding between Phases I and II for Fast Track projects, and result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects. The purpose of the Fast Track is to focus SBIR funding on those projects that are most likely to be developed into viable new products that DoD and others will buy and that will thereby make a major contribution to U.S. military and/or economic capabilities. See Section 4.5 of this solicitation for complete information on the revised Fast Track policy and how to participate.

2. **The Department's SBIR/STTR Help Desk** can address your questions about this solicitation, the proposal preparation process, contract negotiation, payment vouchers, government accounting requirements, intellectual property protection, the Fast Track, obtaining outside financing, and other program-related areas. You may contact the Help Desk by:

Phone:	800-382-4634 (8AM to 8PM EST)
Fax:	800-462-4128
Email:	SBIRHELP@us.teltech.com

3. **The SBIR/STTR Home Page (http://www.acq.osd.mil/sadbu/sbir)** offers electronic access to answers to commonly-asked questions, sample SBIR proposals, model SBIR contracts, abstracts of ongoing SBIR projects, early releases of the SBIR solicitation, the latest updates on the SBIR program, information on the Small Business Technology Transfer (STTR) program, hyperlinks to sources of business assistance and financing, and other useful information.

4. **You may contact the DoD authors of solicitation topics to ask questions about the topics** before you submit a proposal. Procedures for doing so are discussed in Section 1.5(c) of this solicitation. Please note that, to ensure competitive fairness, you may talk by telephone with a topic author to ask such questions only during the six weeks preceding the date on which the solicitation officially opens. At other times, you may submit written questions, and all such questions and the responses will be posted electronically on the Internet for general viewing.

5. **All companies submitting a Phase I or Phase II proposal must complete a Company Commercialization Report (Appendix E)** -- a simplified listing of the commercialization status of the company's prior Phase II efforts (see Section 3.4(n)).

6. **An SBIR proposal that meets the goals of a solicitation topic but does not use the exact approach specified in the topic will still be considered.** For further information on this new Department policy, see Section 4.1 of this solicitation.

7. **The Department has significantly reduced delays in the SBIR proposal evaluation and contracting process.** The median time between proposal receipt and award is now less than 4 months in Phase I and approximately 7 months in Phase II. We are working to further reduce the processing time in Phase II.

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U.S. SPECIAL OPERATIONS COMMAND

OFFICE OF THE SECRETARY OF DEFENSE

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Navy, Air Force, Defense Advanced Research Projects Agency (DARPA), Defense Special Weapons Agency (DSWA), Ballistic Missile Defense Organization (BMDO), Special Operations Command (SOCOM), Joint Chemical Biological Defense (CBD) and Office of the Secretary of Defense (OSD), hereafter referred to as DoD Components, invite small business firms to submit proposals under this solicitation for the Small Business Innovation Research (SBIR) program. Firms with the capability to conduct research and development (R&D) in any of the defense-related topic areas described in Section 8.0, and to commercialize the results of that R&D, are encouraged to participate.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific, technical, and commercial merit and feasibility of ideas submitted under the SBIR Program. Phase I awards are typically $60,000 to $100,000 in size over a period not to exceed six months (nine months for the Air Force). Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific, technical, and commercial feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research or research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications.

Subsequent Phase II awards will be made to firms on the basis of results of their Phase I effort and the scientific, technical, and commercial merit of the Phase II proposal. Phase II awards are typically $500,000 to $750,000 in size over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable prototype. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to obtain funding from the private sector and/or non-SBIR Government sources to develop the prototype into a viable product or non-R&D service for sale in military and/or private sector markets.

This solicitation is for Phase I proposals only. Only proposals submitted in response to this solicitation will be considered for Phase I award. Proposers who were not awarded a contract in response to a prior SBIR solicitation are free to update or modify and re-submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III, and all awards are subject to the availability of funds. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Proposer Eligibility and Limitations

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of <u>two-thirds</u> of the research and/or analytical work in Phase I must be carried out by the proposing firm. For Phase II, a minimum of <u>one-half</u> of the research and/or analytical work must be performed by the proposing firm. The percent of work is usually measured by both direct and indirect costs, although

proposers planning to subcontract a significant fraction of their work should verify how it will be measured with their DoD contracting officer during contract negotiations. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Primary employment with a small business concern precludes full-time employment at another organization. Deviations from the requirements in this paragraph must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, all research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.4 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counselor from the employees' Government agency for further guidance.

1.5 Questions about the SBIR Process and Solicitation Topics

a. General Questions/Information. The DoD SBIR/STTR Help Desk is prepared to address general questions about this solicitation, the proposal preparation process, contract negotiation, payment vouchers, Government accounting requirements, intellectual property protection, the Fast Track, financing strategies, and other program-related areas.
The Help Desk may be contacted by:

Phone: 800-382-4634 (8AM to 8PM EST)
Fax: 800-462-4128
Email: SBIRHELP@us.teltech.com

The DoD SBIR/STTR Home Page offers electronic access to answers to commonly asked questions, sample SBIR proposals, model SBIR contracts, abstracts of ongoing SBIR projects, early releases of the SBIR solicitation, the latest updates on the SBIR program, hyperlinks to sources of business assistance and financing, and other useful information.

DOD SBIR/STTR HOME PAGE:
http://www.acq.osd.mil/sadbu/sbir

b. General Questions About a DoD Component. General questions pertaining to a particular DoD Component (Army, Navy, Air Force, etc) should be submitted in accordance with the instructions given at the beginning of that Component's topics, in Section 8.0 of this solicitation.

c. Technical questions about solicitation topics. Approximately six weeks before this solicitation officially opens on October 1, 1997, the solicitation topics are released electronically on the DoD SBIR/STTR Home Page (**http://www.acq.osd.mil/sadbu/sbir**), along with the names of the topic authors and their phone numbers. This early release gives proposers an opportunity to ask technical questions about specific solicitation topics by telephone before the solicitation opens.

Once a solicitation opens, telephone questions will no longer be accepted, but proposers may submit written questions through the SBIR Interactive Topic Information System (SITIS), in which the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing. Proposers may submit written questions to SITIS via internet (see shortcut bar at the top of the DoD SBIR/STTR Home Page), e-mail, fax, mail, or telephone as follows:

Defense Technical Information Center
MATRIS Office, DTIC-AM
ATTN: SITIS Coordinator
53355 Cole Road
San Diego, CA 92152-7213
Phone: (619) 553-7006
Fax: (619) 553-7053
E-mail: sbir@dticam.dtic.mil
WWW: http://dticam.dtic.mil/sbir/

The SITIS service for this solicitation opens on or around August 20, 1997 and closes to new questions on December 14, 1997. SITIS will post all questions and answers on the Internet (see shortcut bar at the top of the DoD SBIR/STTR Home Page) from August 20, 1997 through January 14, 1998. (Answers will also be emailed or faxed directly to the inquirer if the inquirer provides an e-mail address or fax number.) Answers are generally posted within seven working days of question submission.

1.6 Requests for Copies of DoD SBIR Solicitation

To remain on the DoD Mailing list for the SBIR and STTR solicitations, send in the Mailing List form (Reference G). You may also order additional copies of this solicitation from:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

The DoD SBIR and STTR solicitations can also be accessed via internet through the DoD SBIR/STTR Home Page at **http://www.acq.osd.mil/sadbu/sbir**.

1.7 SBIR Conferences and Outreach

The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. For information on these events, see our Home Page (**http://www.acq.osd.mil/sadbu/sbir**). We have a special outreach effort to socially and economically disadvantaged firms.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, <u>at the time of award</u> of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR Sec. 121.103. The term "number of employees" is defined in 13 CFR Sec. 121.106. Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially and economically disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management of the business.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any Federal Agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal Government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing a product or non-R&D service for sale (whether by the originating party or by others), in Government and/or private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic, although need not use the exact approach specified in the topic (see Section 4.1). Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation, including the instructions in Section 8.0 of the DoD component to which you are applying.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Sec. 5.6.
- Limit your proposal to 25 pages (excluding Company Commercialization Report).
- Use a type size no smaller than 12 pitch or 11 point.
- Do not include proprietary or classified information in the project summary (Appendix B).
- Include a copy of Appendix A, Appendix B, and Appendix E as part of the original of each proposal. (Additional copies of all Appendices can be downloaded from **http://www.acq.osd.mil/sadbu/sbir**).
- Do not use a proportionally spaced font on Appendix A and Appendix B.

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.6.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding Company Commercialization Report (Appendix E), (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, and a maximum of 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. <u>Cover all items listed below in Section 3.4 in the order given.</u> The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding Company Commercialization Report (Appendix E) <u>will not</u> be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed copy of Appendix A, Appendix B and Appendix E.

a. Cover Sheet. Complete and sign Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal. The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summaries of proposals selected for award will be publicly released on the Internet

and, therefore, should not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Commercialization Strategy. Describe, in approximately one page, your company's strategy for converting your proposed SBIR research into a product or non-R&D service with widespread commercial use -- including private sector and/or military markets.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local Governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of <u>two-thirds</u> of the research and/or analytical work in Phase I, as measured by direct and indirect costs, must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support of Similar Proposals or Awards. *Warning* -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the solicitating agency or agencies before award.

If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another Federal Agency or DoD Component or the same DoD Component, the proposer must so indicate on Appendix A and provide the following information:

(1) Name and address of the Federal Agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough

information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a Phase I proposal.

n. Company Commercialization Report on Prior SBIR Awards. All small business concerns submitting a Phase I or Phase II proposal must complete Appendix E (Company Commercialization Report), listing the commercialization status of all of the concern's prior Phase II efforts. (This required proposal information shall not be counted toward proposal pages count limitations.) A Report showing that a small business concern has received no prior Phase II awards will not affect the concern's ability to obtain an SBIR award.

3.5 Bindings

Do not use special bindings or covers. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal Format

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation.

Each Phase II proposal must contain a Cover Sheet (Appendix A), a Project Summary Sheet (Appendix B), and a Company Commercialization Report (Appendix E). In addition, each Phase II proposal must contain a two-page commercialization strategy, addressing the following questions:

(1) What is the first product that this technology will go into?
(2) Who will be your customers, and what is your estimate of the market size?
(3) How much money will you need to bring the technology to market, and how will you raise that money?
(4) Does your company contain marketing expertise and, if not, how do you intend to bring that expertise into the company?
(5) Who are your competitors, and what is your price and/or quality advantage over your competitors?

Copies of Appendices along with additional instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

3.7 False Statements

Knowingly and willfully making any false, fictitious, or fraudulent statements or representations may be a felony under the Federal Criminal False Statement Act (18 U.S.C. Sec 1001), punishable by a fine of up to $10,000, up to five years in prison, or both.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. A proposal that meets the goals of a solicitation topic but does not use the exact approach specified in the topic will be considered relevant. (Prospective proposers should contact the topic author as described in Section 1.5 to determine whether submission of such a proposal would be useful.)

Proposals found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD. DoD is not obligated to make any awards under Phase II or the Fast Track, and all awards are subject to the availability of funds. DoD is not responsible for any monies expended by the proposer before award of a contract.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the Government and the nation considering the following factors.

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.

b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

c. The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.

b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

c. The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the Government. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by Government personnel.

Fast Track Phase II proposals. Under the regular Phase II evaluation process, the above three criteria are each given roughly equal weight (with some variation across the DoD Components). For projects that qualify for the Fast Track

(as discussed in Section 4.5), DoD will evaluate the Phase II proposals under a separate, expedited process in accordance with the above criteria, and will select these proposals for Phase II award provided:

(1) they meet or exceed a threshold of "technically sufficient" for criteria (a) and (b); and

(2) the project has substantially met its Phase I technical goals

(and assuming budgetary and other programmatic factors are met, as discussed in Section 4.1). Fast Track proposals, having attracted matching cash from an outside investor, presumptively meet criterion (c). Consistent with DoD policy, this process should result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential can be evidenced by:

- **a.** The small business concern's record of commercializing SBIR or other research, particularly as reflected in its Company Commercialization Report (Appendix E).
- **b.** The existence of second phase funding commitments from private sector or non-SBIR funding sources.
- **c.** The existence of third phase follow-on commitments for the subject of the research.
- **d.** The presence of other indicators of commercial potential of the idea, including the small business' commercialization strategy (discussed in Sections 3.4.h and 3.6, above).

If a company chooses to submit a third phase follow-on commitment per (c) above, the commitment should state that the small business or a third party will provide follow-on funding in Phase III, and indicate the dates on which the funds will be made available. The commitment should also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms should not be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment should be submitted with the Phase II proposal.

4.5 SBIR Fast Track

a. In General. On a pilot basis, the DoD SBIR program has implemented a streamlined Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort (as well as for the interim effort between Phases I and II). The purpose is to focus SBIR funding on those projects that are most likely to be developed into viable new products that DoD and others will buy and that will thereby make a major contribution to U.S. military and/or economic capabilities.

Outside investors, as defined in DoD's Fast Track Guidance (Reference E), may include such entities as another company, a venture capital firm, an individual investor, or a non-SBIR, non-STTR government program; they do not include the owners of the small business, their family members, and/or affiliates of the small business.

As discussed in detail below, projects that obtain matching funds from outside investors and thereby qualify for the SBIR Fast Track will (subject to the qualifications described herein):

(1) Receive interim funding of $30,000 to $50,000 between Phases I and II;

(2) Be evaluated for Phase II award under a separate, expedited process; and

(3) Be selected for Phase II award provided they meet or exceed a threshold of "technically sufficient" and have substantially met their Phase I technical goals (and assuming other programmatic factors are met), as described in Section 4.3.

Consistent with DoD policy, this process should prevent any significant gaps in funding between Phases I and II for Fast Track projects, and result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects.

b. How To Qualify for the SBIR Fast Track. To qualify for the SBIR Fast Track, a company must submit a Fast Track application within 150 days after the effective start date of its Phase I contract, unless a different deadline for Fast Track applications is specified by the DoD Component funding the project (see the Component's introductory page in Section 8 of this solicitation - the deadlines range from 120 to 180 days). The company is encouraged to discuss the application with its Phase I technical monitor; however, it need not wait for an invitation from the technical monitor to submit either a Fast Track application or a Fast Track Phase II proposal.

A Fast Track application consists of the following items:

(1) A completed Fast Track application form, found at Appendix D. On the application form, the company and its outside investor must:

   (a) State that the outside investor will match both interim and Phase II SBIR funding, in cash, contingent on the company's selection for Phase II award, as described on the form at Appendix D. The matching rates needed to qualify for the Fast Track are as follows:

- For companies that have never received a Phase II SBIR award from DoD or any other federal agency, the minimum matching rate is 25 cents for every SBIR dollar. (For example, if such a company receives interim and Phase II SBIR funding that totals $750,000, it must obtain matching funds from the investor of $187,500.)

- For all other companies, the minimum matching rate is 1 dollar for every SBIR dollar. (For example, if such a company receives interim and Phase II SBIR funding that totals $750,000, it must obtain matching funds from the investor of $750,000.)

(b) Certify that the outside funding proposed in the application qualifies as a "Fast Track investment," and the investor qualifies as an "outside investor," as defined in DoD Fast Track Guidance (Reference E).

(2) A letter from the outside investor to the company, containing:

(a) A commitment to match both interim and Phase II SBIR funding, in cash, contingent on the company's selection for Phase II award, as discussed on the form at Appendix D.

(b) A brief statement (less than one page) describing that portion of the effort that the investor will fund. The investor's funds may pay for additional research and development on the company's SBIR project or, alternatively, they may pay for other activities not included in the Phase II contract's statement of work, provided these activities further the development and/or commercialization of the technology (e.g., marketing).

(c) A brief statement (less than one page) describing (i) the investor's experience in evaluating companies' ability to successfully commercialize technology; and (ii) the investor's assessment of the market for this particular SBIR technology, and of the ability of the company to bring this technology to market.

(3) A concise statement of work for the interim SBIR effort (less than four pages) and detailed cost proposal (less than one page). Note: if the company has already negotiated an interim effort (e.g., an "option") of $30,000 to $50,000 with DoD as part of its Phase I contract, it need only cite that section of its contract, and need not submit an additional statement of work and cost proposal.

The company should send its Fast Track application to its Phase I technical monitor, with copies to the appropriate Component program manager and to the DoD SBIR program manager, as indicated on the back of the application form.

Also, in order to qualify for the Fast Track, the company:

(1) Must submit its Phase II proposal within 180 days after the effective start date of its Phase I contract, unless a different deadline for Fast Track Phase II proposals is specified by the DoD Component funding the contract (see the Component's introductory page in Section 8 of this solicitation - the deadlines range from 150 days to 210 days).

(2) Must submit its Phase I final report by the deadline specified in its Phase I contract, but not later than 210 days after the effective start date of the contract.

(3) Must certify, within 45 days after being notified that it has been selected for Phase II award, that the entire amount of the matching funds from the outside investor has been transferred to the company. Certification consists of a letter, signed by both the company and its outside investor, stating that "$_____ in cash has been transferred to our company from our outside investor in accord with the SBIR Fast Track procedures." The letter must be sent to the DoD contracting office along with a copy of the company's bank statement showing the funds have been deposited. IMPORTANT: If the DoD contracting office does not receive, within the 45 days, this certification showing the transfer of funds, the company will be ineligible to compete for a Phase II award not only under the Fast Track but also under the regular Phase II competition, unless a specific written exception is granted by the Component's SBIR program manager. Before signing the certification letter, the company and investor should read the cautionary note at Section 3.7. If the outside investor is a non-SBIR/non-STTR DoD program, it must provide a line of accounting within the 45 days that can be accessed immediately.

Failure to meet these conditions in their entirety and within the time frames indicated will generally disqualify a company from participation in the SBIR Fast Track. Deviations from these conditions must be approved in writing by the contracting office.

c. Benefits of Qualifying for the Fast Track. If a project qualifies for the Fast Track:

(1) It will receive interim SBIR funding of $30,000 to $50,000, commencing approximately at the end of Phase I. Note: Consistent with DoD policy, the vast majority of projects that qualify for the Fast Track should receive interim SBIR funding. However, the DoD contracting office has the discretion and authority, in any particular instance, to deny interim funding when doing so is in the Government's interest (e.g., when the project no longer meets a military need or the statement of work does not meet the threshold of "technically

sufficient" as described in Section 4.3).

(2) DoD will evaluate the Fast Track Phase II proposal under a separate, expedited process, and will select the proposal for Phase II award provided it meets or exceeds a threshold of "technically sufficient" for evaluation criteria (a) and (b), as described in Section 4.3 (assuming budgetary and other programmatic factors are met, as discussed in Section 4.1). Consistent with DoD policy, this process should result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects. However, DoD is not obligated, in any particular instance, to award a Phase II contract to a Fast Track project, and DoD is not responsible for any funds expended by the proposer before award of a contract.

(3) It will receive notification, no later than ten weeks after the completion of its Phase I project, of whether it has been selected for a Phase II award.

(4) If selected, it will receive its Phase II award within an average of five months from the completion of its Phase I project.

d. Additional Reporting Requirement. In the company's final Phase II progress report, it must include a brief accounting (in the company's own format) of how the investor's funds were expended to support the project.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.3) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than July 14, 1998. *The DoD Components anticipate making 500 Phase I awards from this solicitation.* On average, 1 in 8 Phase I proposals receive funding.

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.5). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. The typical size of award varies across the DoD Components; it is therefore important for a proposer to read the introductory page of the Component to which it is applying (in Section 8.0) for any specific instructions regarding award size.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately one-third of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. See special instructions for each DoD Component in Section 8.

5.3 Phase I Report

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, monthly status and progress reports may be required by the DoD agency. (A blank SF 298 is provided in Section 9.0, Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the

SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:

(a) Approved for public release; distribution unlimited.
(b) Distribution authorized to U.S. Government Agencies only; contains proprietary information.

(3) Block 13 (Abstract) of the SF 298, "Report Documentation Page") must include as the first sentence, "Report developed under SBIR contract". The abstract must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract will be published by the DoD, it must not contain any proprietary or classified data.

(4) Block 14 (Subject Terms) of the SF 298 must include the term "SBIR Report".

c. Submission. SIX COPIES of the final report on each Phase I project shall be submitted to the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, 8725 John J Kingman Road, Suite 0944, Ft. Belvoir, VA 22060-6218.

5.4 Other Reports

If asked, the contractor will be required to provide DoD with a report during Phase II, and each year for five years after completion of Phase II, detailing: (1) the revenue from sales of new products or non-R&D services resulting from the SBIR project, and (2) the sources and amounts of non-SBIR, non-STTR funding received from the Government and/or private sector sources to further develop the SBIR technology.

5.5 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly payments may be made. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.6 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)________of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The Government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

If all of the information on a particular page is proprietary, the proposer should so note by including the word "PROPRIETARY" in both the header and footer on that page.

The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for

any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.7 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgment and disclaimer statement.

5.8 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a period of five years to allow the awardee to pursue a patent.

5.9 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation generally remain with the contractor, except that the Government obtains a royalty-free license to use such technical data only for Government purposes during the period commencing with contract award and ending five years after completion of the project under which the data were generated. Upon expiration of the five-year restrictive license, the Government has unlimited rights in the SBIR data. During the license period, the Government may not release or disclose SBIR data to any person other than its support services contractors except: (1) For evaluational purposes; (2) As expressly permitted by the contractor; or (3) A use, release, or disclosure that is necessary for emergency repair or overhaul of items operated by the Government. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252.227-7018, "Rights in Noncommercial Technical Data and Computer Software -- SBIR Program."

5.10 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.11 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.12 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical work must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical work must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

The percentage of work is usually measured by both direct and indirect costs, although proposers planning to subcontract a significant fraction of their work should verify how it will be measured with their contracting officer during contract negotiations.

5.13 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of Government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to Government inspection and evaluation at all

reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The Government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.14 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The Government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M). The Manual is available on-line at **http://www.dis.mil** or in hard copy from:

Defense Investigative Service
1340 Braddock Place
Alexandria, VA 22314
Phone: (703) 325-5324

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED APPENDIX A (COVER SHEET), APPENDIX B (PROJECT SUMMARY), AND APPENDIX E (COMPANY COMMERCIALIZATION REPORT).

6.1 Address

Each proposal or modification thereof shall be submitted in sealed envelopes or packages addressed to that DoD Component address which is identified for the specific topic in that Component's subsection of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number, the topic number for the proposal, and the time and date specified for proposal receipt must be clearly marked on the outside of the envelope or package. To protect your proposal against rough handling, damage in the mail, and the possibility of unauthorized disclosures, it is recommended that your proposal be double-wrapped and that both the inner and outer envelopes or wrappings be clearly marked.

Offerors using commercial carrier services shall ensure that the proposal is addressed and marked on the outermost envelope or wrapper as prescribed above.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, January 14, 1998. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than January 7, 1998 or (b) it was sent by mail and it is determined by the Government that the late receipt was due solely to mishandling by the Government after receipt at the Government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U.S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the Government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding Company Commercialization Report). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the Government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals. The written

request should be sent to the DoD organization that notified the proposer that the proposal was not selected for award.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

The Defense Technical Information Center (DTIC) provides information services to assist SBIR participants in proposal preparation, bid decisions, product development, marketing and networking. The following services are available at no cost to the SBIR user.

1. **Technical Information Packages (TIPs)**, bibliographic listings of related DoD-funded work are prepared for the majority of SBIR topics. Request TIPs in hard copy by mailing in Reference B at the back of this solicitation, or by telephone, fax or e-mail. Online TIPs (OLTIPS) are available on the DTIC SBIR web site **(http://www.dtic.mil/dtic/sbir).**
2. **Public STINET**, DTIC's online technical database, is on the web site. SBIR participants are encouraged to search the database for documents in their areas of interest.
3. **Full Text Documents** are also on the web site, including a large selection of SBIR related technical reports.
4. **ECAB**, an e-mail document alert service available to SBIR/STTR participants, is a listing of new DTIC accessions that match the recipient's personal interest profile, sent bimonthly.
5. **Free Reports**: A firm may receive a total of ten hard copy technical reports at no cost from DTIC during a solicitation period. Additional reports, custom bibliographies, and services requested during non-solicitation periods may be charged to a credit card or deposit account.
6. **SITIS**, providing answers to specific technical questions concerning DoD topic descriptions, is also on the web site. See the description of SITIS in Section 1.5.c.

DTIC is a major component of the DoD Scientific and Technical Information Program, managing the technical information resulting from DoD-funded research and development. DTIC also manages and provides access to specialized information services and subject matter expertise. MATRIS, a DTIC component, is the focal point for information on manpower, training systems, human performance, and human factors **(http://dticam.dtic.mil).** The DTIC-managed Centers for Analysis of Scientific and Technical Information (the IACs) are the DoD centers of expertise concerned with engineering, technical and scientific documents and databases worldwide **(http://www.dtic.mil/iac/).**

Call or visit (by prearrangement) DTIC at the location most convenient to you. Written communications should be made to the Ft. Belvoir address.

ATTN: DTIC-SBIR
Defense Technical Information Center
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
Ph: (800) 363-7247
Fax: (703) 767-8228
Email: sbir@dtic.mil
WWW: http://www.dtic.mil/dtic/sbir

DTIC Boston Regional Office
Building 1103
5 Wright Street Hanscom AFB
Bedford, MA 01731-5000
(781) 377-2413

DTIC Albuquerque Regional Office
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Dayton Regional Office
2690 C Street, Suite 4
Wright-Patterson AFB, OH 45433-7552
(937) 255-7905

DTIC Los Angeles Regional Office
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600
(703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
301 Tarrow, Suite 119
College Station, TX 77843-8000
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical areas in which DoD Components request proposals for innovative R&D from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the Component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Component Topic Sections — Pages

Appendices A, B, C, D and E follow the Component Topic Sections. Appendix A is a Proposal Cover Sheet, Appendix B is a Project Summary form, Appendix C is an outline for the Cost Proposal, Appendix D is the Fast Track Application Form, and Appendix E is the Company Commercialization Report. A completed copy of Appendix A, Appendix B, and Appendix E, as well as a completed Cost Proposal, must be included with each proposal submitted.

Many of the topics in Section 8 contain references to technical literature or military standards, which may be accessed as follows:

- References with "AD" numbers are available from DTIC, by calling 800/DoD-SBIR or sending an e-mail message to sbir@dtic.dla.mil
- References with "MIL-STD" numbers are available from the DoD Index of Specifications and Standards (DODISS) at Internet address http://www.dtic.mil/dps-phila/dodiss
- Other references can be found in your local library or at locations mentioned in the reference.

CHEMICAL AND BIOLOGICAL DEFENSE PROGRAM

General Information

In response to Congressional interest in the readiness and effectiveness of U.S. Nuclear, Biological and Chemical (NBC) warfare defenses, Title XVII of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160) required the Department of Defense (DoD) to consolidate management and oversight of the Chemical and Biological Defense (CBD) program into a single office within the Office of the Secretary of Defense. The public law also directed the Secretary of Defense designate the Army as the Executive Agent for coordination and integration of the CBD program. The executive agent for the SBIR portion of the program is the Army Research Office-Washington (ARO-W).

The objective of the DoD CBD program is to enable U.S. forces to survive, fight and win in chemical and biological warfare environments. Numerous rapidly-changing factors continually influence the program and its management. These forces include declining DoD resources, planning for warfighting support to numerous regional threat contingencies, the evolving geopolitical environment resulting from the breakup of the Soviet Union, U.S. participation in the Chemical Weapons Convention, and the continuing global proliferation of chemical and biological weapons. Improved defensive capabilities are essential in order to minimize the impact of the use of such weapons. U.S. forces require aggressive, realistic training and the finest equipment available that allows them to avoid contamination, if possible, and to protect, decontaminate and sustain operations throughout the non-linear battlespace.

The overall objective of the CBD SBIR program is to improve the transition or transfer of innovative CBD technologies between DoD components and the private sector for mutual benefit. The CBD program includes those technology efforts that maximize a strong defensive posture in a biological or chemical environment using passive and active means as deterrents. These technologies include chemical and biological detection; information assessment, which includes identification, modeling and intelligence; contamination avoidance; and protection of both individual soldiers and equipment.

Tri-Service Program

The U.S. Army, Navy, and Air Force have developed 15 separate SBIR topics for research and development in various CBD areas of interest. As lead agency, the Army will coordinate Tri-Service efforts related to the receipt, evaluation, selection, and award of Phase I proposals and similarly for potential follow-on Phase II efforts under this program.

Topic Submission

All proposals submitted in response to CBD topics must be mailed to the address provided below. Potential offerors must follow the proposal submission rules for the agency which has proponency for topics. Topics are numbered in series, with Army topics starting at 101 and running to 107, Navy topics numbered 201 through 207. There is only one Air Force topic, numbered 301. Detailed instructions for proposals to be submitted against Army topics are given below. **Refer to the appropriate Navy and Air Force sections in this Solicitation for information on how to prepare proposals for submission against Navy and Air Force CBD topics.**

Notice for Navy proposers: The Army Research Office-Washington is not equipped to handle online (Internet or e-mail) proposals or Appendix A & B submissions. For all Navy an original and four copies must be submitted to the address provided below. Supplementary diskettes required by the Navy will also be accepted.

Army CBD Proposal Guidelines

The maximum dollar amount for proposals submitted against Army CBD Phase I topics is $100,000 and for Phase II awards is $750,000. Selection of Phase I proposals will be based upon technical merit, according to the evaluation procedures and criteria discussed in this solicitation document. Due to limited funding, the Army reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded. To reduce the funding gap between Phase I and Phase II, the Army follows a disciplined milestone process for soliciting, evaluating, and awarding superior Phase II proposals. Phase II proposals are invited by the Army from Phase I projects which have demonstrated the potential for commercialization of useful products and services. Invited Phase II proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing developed technology. Cost sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged, as are matching funds from independent third-party investors, per the SBIR fast track (see section 4.5). Instructions for submitting a Phase II proposal will be issued as part of the contract package for Phase I winners.

Proposals not conforming to the terms of this solicitation and unsolicited proposals will not be considered. Awards are made contingent on availability of funding and successful completion of negotiations.

Mailing Address for all CBD topics

Dr. Kenneth A. Bannister
U. S. Army Research Office - Washington
Room 8N23
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
Telephone: (703) 617-7425

PROPOSAL CHECKLIST

This checklist is provided to assist in preparing your proposal for submission. Please review the checklist carefully to assure that you proposal meets the SBIR requirements. Failure to meet these requirements may result in your proposal being returned without consideration. Do not include this checklist with your proposal.

_____ 1. The proposal is limited to only one solicitation topic.

_____ 2. The proposal is 25 pages or less in length. (Excluding company commercialization report.) Proposals in excess of this length will not be considered for review or award.

_____ 3. The Cover Sheet (Appendix A) is complete and is PAGE 1 of the proposal

_____ 4. The Project Summary Sheet (Appendix B) is complete and is PAGE 2 of the proposal.

_____ 5. The Technical Content of the proposal begins on PAGE 3 and includes the items identified in Section 3.4 of the solicitation.

_____ 6. The Technical Abstract contains no proprietary information, does not exceed 200 words, and is limited to the space provided on the Project Summary Sheet (Appendix B).

_____ 7. The proposal contains only pages of 8 1/2 x 11 size. No other attachments such as disks, video tapes, etc. are included.

_____ 8. The proposal contains no type smaller than 11 point font size (except as legend on reduced drawings, but not tables).

_____ 9. The Cost Proposal (Appendix C) is complete, is signed with an original signature, and is included as the last section of the proposal.

_____ 10. The proposals are stapled in the upper-left-hand corner, and no special binding or covers are used.

_____ 11. An original and four copies of the proposal are submitted.

_____ 12. The Company Commercialization Report, (Appendix E), is included in accordance with Section 3.4.n. (This report does not count towards the 25 page limit)

_____ 13. Acknowledgment of proposal receipt will be sent if the proposal includes a self-addressed stamped envelope and Reference B needing only a signature showing receipt is included.

INDEX OF CHEMICAL BIOLOGICAL DEFENSE FY98 TOPICS

Army CBD Topics

Navy CBD Topics

Air Force CBD Topic

CHEMICAL BIOLOGICAL DEFENSE KEYWORD INDEX

CHEMICAL BIOLOGICAL DEFENSE TOPIC DESCRIPTIONS

CBD98-101 TITLE: Labeless Methods of Biodetection

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Advanced Development

OBJECTIVE: Develop a biodetector that does not require labeling reagents such as fluorescent, radioisotopic or enzymatic tags, i.e. a "reagentless sensor."

DESRIPTION: Most biosensors rely on some sort of reporter label attached to either an antibody or DNA. This label enables a detection event to be transduced by the sensor into a signal. One biodetection goal is to detect toxins, viruses, and bacteria using sensing techniques that do not require the use of labels. Detection is to take place through a direct chemical, biochemical, or physical action.

PHASE I: Phase I will be a proof-of-principle of the proposed technique. A sensing scheme and appropriate hardware are to be developed and tested with a model protein, virus/bacteriophage, and bacteria. Highest consideration will go to those methods that propose to detect all three classes as well as those that also will focus on limiting background and non-specific binding effects, achieving high sensitivity, and broadening the dynamic range.

PHASE II: The basic method(s) of Phase I will be optimized and extended to matrices of background contaminants and sets of proteins, viruses/bacteriophages, and bacteria. The end product will be a fully functional optimized piece of hardware. A fully optimized sensor system must be a deliverable to the Government to include, where applicable: initial training, consumables, six months service/repair support, and one years technical support. Finally, a solid and realistic commercialization plan is essential.

PHASE III DUAL USE APPLICATIONS: Medical diagnostics, industrial and environmental monitoring.

KEY WORDS: Biosensors, labeless detection, biodetection.

CBD98-102 TITLE: Microfabrication Based Biodetectors

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Advanced Development

OBJECTIVE: Reduce the size and sample and power needs of biodetectors using microfabrication.

DESCRIPTION: Microfabrication methods offer the possibility of producing biosensors and biodetector components of unprecedented smallness (ie. chip based) as well as enabling novel designs, chemistries, and general biosensing approaches not possible with macrofabricated systems. Biological detection goals include deployment of microfabricated sensor systems that are capable of processing and analyzing microliter amounts of sample for a variety of threat bioagents: toxins, viruses, and bacteria. Such systems would include microfabricated pumps, actuators, reaction platforms, fluidic systems, detectors, and sample isolation systems; all automated into a continuous process. Such systems would be able to take sample from the macro world and process and analyze it in a microfabricated environment.

PHASE I: A successful Phase I effort will be one where the feasibility of applying microfabrication technology to aspects of immunochemical and/or DNA biosensing are demonstrated. For a Phase I effort, a laboratory based proof-of-principle is sufficient. Topics for consideration include the areas listed in paragraph 1.a.2 above. However, greatest consideration will be given to proposals that seek to develop microfabricated sensing platforms; and sample isolation, cleanup, and separation methods. DNA analysis and processing will be given priority over antibody or physical methods. The topic calls for more than an engineering effort - concept demonstration must be tied to an actual biochemical system (ie. detecting a sample or isolating it).

PHASE II: A successful Phase II will optimize the technology or methods demonstrated in Phase I and then develop a fully functional and optimized microfabricated biosensing system or system module. A fully optimized sensor system/component must

be a deliverable to the Government to include, where applicable: initial training, consumables, six months service/repair support, and one years technical support. Finally, a solid and realistic commercialization plan is essential.

PHASE III DUAL USE APPLICATIONS: Diagnostics, industrial monitoring and process control, environmental pollution assessment.

KEYWORDS: Microfabrication, biosensors.

CBD98-103 TITLE: Large Scale Production of Antibodies in Transgenic Animals

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Exploratory Development

OBJECTIVE: Investigate feasibility of moderate scale production of recombinant antibodies in transgenic systems.

DESCRIPTION: The SBIR should address the Fab fragment antibody procurement needs of the DoD through the production of the recombinant protein in the milk of a cow, rodent, pig, rabbit, or sheep. The total yearly production needs range in the 15 gram to 100 gram range and it is expected that multiple clones will eventually need to be produced in this fashion. The SBIR aims to develop methodology whereby the high cost of transgenics can be amortized through multiple clones over several years. The smaller scale of production, in comparison to traditional transgenic projects, could offer the SBIR company the ability to penetrate the lower end of the production market. The intended advantages of the system should include large scale production of the antibody, easily transferred purification technology, and the ability to test for successful production within 9 months of the initiation of the project. The production of transgenic animal production lines is not an absolute requirement of the SBIR and methods employing an insertion of the genes of interest directly into the mammary epithelium are also acceptable. It is understood that in this method genetic modification is limited to somatic cells - the mammary epithelium - and the exogenous genes are not transmitted to the offspring.

PHASE I: Phase I would involve the production of at least two individual antibody clones in the desired system. Confirmation of successful construct or genetic uptake should be provided during this period.

PHASE II: This would involve the delivery of at least 5 grams of purified antibody and the transfer of purification methodology. Optimization of purification systems and issues relating to extraction of the product will be resolved. Test samples (i.e., by induced lactation or sampling) should be provided with 1.5 years of the start date.

PHASE III DUAL USE APPLICATIONS: The high cost of transgenics often prohibits the use of this technology for moderate scale production needed for many applications. The development of this technology and the need for multiple clones should allow the company to streamline its procedures. This may allow the penetration of the lower end production markets. Additionally the production of human antibodies by recombinant means can have a dual use in therapeutics and imaging applications.

KEY WORDS: Transgenics, antibodies

CBD98-104 TITLE: Intermolecular Force Measurements for Molecular Identification

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Exploratory Development

OBJECTIVE: Detect biological agents by measuring intermolecular forces.

DESCRIPTION: Miniaturization of mechanical and electronic devices and increasing abilities to manipulate macromolecules have resulted in technology that provides the possibility of measuring interactive forces between individual macromolecules and microscopic structures. Such force measurements could be used to identify molecules by the forces they exert on known molecules or microstructures. The U.S. Army ERDEC envisions using this knowledge to detect and identify chemical and biological battlefield threats by using, for example, an array of immobilized antibodies that would interact with antigens with a measurable force.

The goal of the project is to successfully use the one-to-one mapping capability of cantilever based technology and thus to effect single particle detection and identification. By virtue of design this provides sensitivity on the level of a single virus, particle or molecule. The ultimate sensitivity of the detector will depend on the efficiency of the front end sampling system used. This topic

focuses on the detection and identification aspects while contractors are encouraged to consider the requirement of eventually marrying the system to an appropriate sampler. Inclusion of an efficient sampling scheme is encouraged but not required. The entire system, including sampler, should be capable of detecting and identifying particles in concentrations down to 1 particle per liter.

In terms of specificity, the minimum useful level would be the ability to differentiate between pathogenic and nonpathogenic particles. Such a system would be useful but on a very limited basis. The desired level of specificity is the ability to differentiate between the major biological agent suspects (B. anthracis, C. botulinum, Y. pestis and viral threats). The ideal system would derive its specificity from the measured interactions between unknown sample and a generic interacting probe, thus relieving the need for predetermination of specific potential threats. This way the limits to specificity would be based on databases rather than on hardware design. Due to the difficulties and dangers of testing with live agents it is considered reasonable to test with standard biological agent simulants or to test with inactivated agents provided the mechanism of detection is proven unaffected by inactivation of agents (this is not expected to be the case with most approaches).

The final device should be readily portable, on the size scale of a PC. It should be able to complete detection in less than ten minutes. The military applications require that the final product be rugged for field application. Military applications also require that it be simple enough to use that troops can be readily trained to operate it effectively.

PHASE I The contractor will be expected to develop a method to measure intermolecular forces and demonstrate repeatability of such measurements. The contractor will also determine the practicality of distinguishing between very small forces as a method of identifying the interacting particles, using either a threshold or quantitative approach. The approach should allow for a final product that is versatile with respect to the molecules to be used as probes. It should be kept in mind that the final application requires an interface with sampling technology. In Phase I the contractor will also plan a prototype user friendly device incorporating these measurements.

PHASE II: The contractor will build and test a prototype device for measuring intermolecular forces and/or forces between macromolecules and small structures. This phase will include communication between the device and output devices as well as a complete study of data analysis and interpretation, as required to translate raw force measurements into useful information.

PHASE III DUAL USE POTENTIAL: Medical diagnostics, environmental monitoring, medical research

KEY WORDS: Atomic force, molecular identification, biodetection, pathogen identification, molecular force, cellular force.

CBD98-105 TITLE: Automated Bacterial Detection with Electrospray Ionization Mass Spectrometry

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Basic Research

OBJECTIVE: Successful results from this effort will result in an on-line, automated system that processes protein toxin and bacterial samples, releases and separates biomarker compounds, and transfers and detects the compounds with electrospray ionization mass spectrometry.

DESCRIPTION: The detection and identification of pathogenic biological species has been the subject of many analytical techniques. Mass spectrometry techniques comprise analytical dimensions which have the capability of providing a wide mass range window for a majority of the biomarker biochemical constituents in bacteria and protein toxins. The diversity of well-characterized, biochemical constituents in pathogenic bacteria and the protein toxins can lend themselves to detection of presence and identification based on mass patterns. Key biomarker constituents of bacteria include proteins, DNA and phospholipids. Phospholipids are known to be sensitive to cell viability. Within hours of the death of a bacterial cell, the phospholipids are quickly degraded. Thus, dead cells would not provide the phospholipid set of biomarkers.

Current methods can detect and characterize the various biochemical marker bacterial compounds at the picogram levels, and this is roughly equivalent to 1000 Gram positive cells. Protein toxins have been successfully analyzed by electrospray ionization mass spectrometry at the picogram-femtogram levels. Methods are needed in order to automate the handling and processing of microorganisms and the efficient transfer of the many discrete bacterial biochemical components and protein toxin compounds to a mass spectrometry based detector. Proposals shall concentrate on the aspects of bacterial and protein toxin processing and handling, extraction of key biochemicals, separation stage(s), purification steps and efficient transfer to an electrospray ionization mass spectrometry detector.

PHASE I: A concept system shall be proposed and demonstrated as a self-contained, automated device for accepting bacterial and protein toxin samples, processing the samples, and yielding relatively pure, well-characterized biochemical constituents for introduction into an electrospray ionization mass spectrometry detector. Candidate bacterial and protein toxin biomarkers and the microbiological/biochemical/chemical/physical methods of biomarker extraction shall be identified. Preliminary evaluation and

laboratory tests and procedures shall be implemented in order to ascertain the optimal detection/identification information content of the candidate biomarkers and the logistic requirements of the respective extraction processing methods.

PHASE II: Two breadboard systems shall be constructed. Elements of the system shall include, but not be limited to, a bacterial and protein toxin sample processing and extraction module, a component to allow for separation of the various biomolecules, biomolecule purification and transfer into an electrospray-tandem mass spectrometry system. Salts and interference matrices shall also be eliminated in order to provide for a satisfactory mass spectral signal for the sample analyte biomarkers. The footprint and power requirements of the system shall be less than or equal to 3x2x2 feet and 400 watts, respectively.

PHASE III DUAL USE APPLICATIONS: An automated bacterial and protein toxin processing system coupled to a highly sensitive and robust analytical mass spectrometer would benefit the biotechnology QA/QC sector enormously. The automated, on-line technology could also be used for screening of new potential pharmaceuticals, medicines, and medically-related compounds where many samples collected from a wide variety of sources need to be analyzed in a relatively short period of time. Labor costs could be significantly reduced with such a proposed system.

KEYWORDS: Bacteria processing, automation, on-line processing, protein toxin detection, electrospray ionization, mass spectrometry, biomarkers, bacteria detection, bacteria identification.

CBD98-106 TITLE: Fast, Low Power Consumption Gas Chromatograph

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate feasibility of development of a Gas Chromatograph for field analyses of volatile and semi-volatile organic chemicals. The GC is to consume less than 10 watts of electrical power during continuous use and will be compatible with other field analytical instruments.

DESCRIPTION: A number of attempts to develop small, low power consumption GC devices have been described in recent years. So far, all suffer from similar problems, i.e., unacceptable power consumption, lack of uniform heating, and inadequate sensing of column temperatures. The goal of this topic is to develop a GC instrument that requires very little electrical power (10 watts continuous power consumption is set as an upper limit) yet provides temperature programming that allows analyte separation and analyses to be performed to produce low limits of detection and good interference rejection for small field detection and analysis systems. Inherent in the development is a suitable vapor sampling inlet for the device. GC system reliability is paramount. It is desirable that the GC device be compatible with other field analytical instruments such as hand-held ion mobility spectrometers, surface acoustic wave devices, portable mass spectrometers, etc.

PHASE I: The desired output of Phase I is a breadboard temperature programmable GC device that demonstrates through laboratory experimentation the goals of the Topic. Demonstrations should be toward determinations of organic materials in air and water.

PHASE II: Phase II should result in field demonstration of concepts that were developed in Phase I and should result in several copies of a prototype device that demonstrates potential for commercial applications.

PHASE III DUAL USE APPLICATIONS: Market potential is in field screening for toxic chemicals in the environment, i.e., the environmental monitoring market -- chemical warfare detection is a subset of environmental monitoring.

KEYWORDS: Gas chromatography, Chemical Warfare detectors, Field screening, Hand-held detectors, Chemical detection, Air monitor, Environmental monitors, Water monitor

CBD98-107 TITLE: Hand-Held Gas Chromatography-Mass Spectrometry

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Exploratory Development

OBJECTIVE: This topic addresses the fabrication of a true hand-held, gas chromatography-mass spectrometer (GC-MS) device.

DESCRIPTION: The ability of an analytical device to replace the discriminatory power of the human nose for chemical vapors is a long sought-after goal in many areas of vapor detection applications. Mass spectrometry is a sensitive and comprehensive analytical detection and identification tool, however, it can be overwhelmed and confused by high sample concentration and when an analyte is present in a complex mixture. Mass spectrometry lends itself to accurate chemical sample analyses because of unique chemical signatures based on signal intensity and mass patterns. When coupled to a gas chromatograph, the dimension of separation allows for a distillation of the many interferences which can be present in complex, vapor samples. Thus, the MS has a relatively pure analyte to interrogate. A GC-MS system is the gold standard with respect to chemical vapor identification.

PHASE I: A concept system shall be proposed and demonstrated as a self-contained, hand-held chemical vapor sampling device based on GC-MS technology. Ambient air or its equivalent may be used as carrier gas. A bottled gas canister will not be considered as a source of carrier gas.

PHASE II: Three breadboard, hand-held portable, GC-MS vapor sampling systems shall be fabricated. The breadborad unit shall not exceed 30 pounds. The GC column shall not experience appreciable degradation at 100 C over a period of 8 hours of continuous use. The GC component shall be modular in nature so as to facilitate convenient column replacement onto the MS detector. The ionization component of the MS detector shall include, but not necessarily be limited to, election ionization.

PHASE III DUAL USE APPLICATIONS: In addition to accurate, unambiguous chemical agent identification for military use, Treaty Verification (CWC) and Demilitarization of chemical agent applications would benefit to a great extent. A hand-held GC-MS device has comprehensive implications for environmental (EPA, USHA, Superfund, monitoring hazardous waste sites for fugitive emissions) screening, detection and identification applications. Current, relatively large detection techniques, including standard laboratory-sized GC-MS instruments, can realistically be replaced by a hand-held GC-MS device. Indoor monitoring of vapors in factories and QA/QC assembly lines can be accomplished with a hand-held GC-MS. A most appealing aspect of a hand-held GC-MS device is its relatively low cost in quantity and high return on investment. Obtaining sample identification information in the field would significantly reduce the steps and cost in chain-of-custody for contaminants. Thus, legal, defensible evidence can be directly derived from a hand-held chemical vapor identification device.

KEYWORDS: hand-held device, gas chromatography, mass spectrometry, chemical vapor, GC-MS, environmental monitoring, chemical identification

CBD98-201 TITLE: CBW Ensemble Pass-Through for a Man-Mounted Microclimate Cooling System

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Exploratory Development

OBJECTIVE: To develop a CB protective ensemble pass-through capability that would allow a liquid active microclimate cooling system to circulate cooling fluid from a torso garment to an external man-mounted system without compromising CB protection.

DESCRIPTION: Current Chemical/Biological (CB) protective ensembles impose a thermal burden on aircrew which not only limits mission time but poses a physiological danger to aircrew operating in even moderate temperature environments. A small man-mounted cooling system employing active liquid based technology would enhance mission effectiveness and more importantly, would prevent a hazardous rise in core body tempeŕature. Active liquid systems consist of a torso garment worn directly over the skin, a fluid reservoir, a circulating pump that is worn external to the ensemble, and connecting hoses. These state-of-the-art systems, however, were not designed to be utilized in a CB environment. Therefore, a self-sealing, CB agent hardened, quick disconnect pass-

through device or garment provision is required to integrate the torso garment with the circulating pump without compromising CB protection. The device shall be decontaminable and reusable.

PHASE I: Examine current state-of-the-art microclimate cooling system technology and develop a device for integrating a torso cooling garment with a man-mounted cooling unit when utilized in a CB environment. A report and prototype shall be delivered to NAWCADPAX.

PHASE II: Perform detailed design and finished development of pass-through device. Fabricate and deliver 3 pass-through devices for laboratory evaluation at NAWCADPAX. Laboratory evaluation results will be provided to the contractor for incorporation into the final developed product. Three shall be delivered along with a final report. These final 3 systems shall represent the final configuration based on Navy evaluation. Integration with latest technology cooling systems shall also be verified.

PHASE III: Initiate the production program for the CBW ensemble pass-through and transition into the USN CB garments. Also transition into other military services garments and similar industrial protective garments.

PHASE III DUAL USE APPLICATIONS:: This technology can be used by other military services, as well as for commercial and industrial applications operating in similar environments.

REFERENCES: SBIR, NAWCADPAX, Phase Change Material (PCM) Enhanced Man-mounted Liquid Active Microclimate Cooling System

KEY WORDS: microclimate cooling, chemical/biological, pass-through, CB ensemble, man-mounted

CBD98-202 TITLE: CBW Low Profile Man-Mounted Filter and Blower Unit

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Advanced Development

OBJECTIVE: Develop a Chemical/Biological Warfare (CBW) protective low profile man-mounted blower unit with filter canister that is lighter, and more compact while providing performance equal to or better than existing blower unit combinations. The blower unit shall be powered by a battery and integrate with a low profile filter canister that provides agent protection equivalent to, or better than, existing systems.

DESCRIPTION: Current man-mounted blower units and filter canister combinations are bulky and protrude from the front of the aircrew overvest making it difficult for aircrew to maneuver in the cockpit. They also present a risk for getting hung-up in the controls during flight and/or snagging during emergency egress. This can result in an in-flight hazard and also impede emergency egress.

PHASE I: Examine current state-of-the-art blower and filter technology and develop an improved system for use in a CBW contaminated environment. A report shall be delivered to NAWCADPAX on the recommended system.

PHASE II: Perform detailed design and development and deliver 6 blower units (with filter canisters and batteries) and final report to the US Navy for testing. Laboratory evaluation results will be provided to the contractor for incorporation into the final developed system. Integration with current aircrew life support systems will also be verified.

PHASE III: Start production of blower units and initiate transition to USN/USMC rotary and tactical aircrew and into similar industrial applications.

PHASE III DUAL USE APPLICATIONS:: This technology has great potential for use by other services, as well as for hazmat, industrial spill, and chemical weapon destruction personnel who require protective ensembles.

KEY WORDS: CBW, blower unit, filter canister, man-mounted, battery

CBD98-203 TITLE: Improved CBW Protective Hood Material

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Exploratory Development

OBJECTIVE: Develop a new state-of-the-art Chemical/Biological Warfare (CBW) protective hood material that is impermeable to CB agents, breathable for release of heat and sweat vapor, fire resistant, easily decontaminable, durable, easy to maintain and that can be bonded to polycarbonate. This improved material shall also be able to be shaped to conform to the head without compromising its protective characteristics.

DESCRIPTION: CBW hood cowls that are manufactured from impermeable materials provide the best level of protection. However, these same hood cowls impose the highest heat stress on the wearer. Current US Navy hood cowls are manufactured of butyl and bromo-butyl rubber and are very hot. This heat build-up within the hood degrades mission performance. Therefore, a new material is sought that would replace the current rubber material thus reducing the thermal burden. This new material shall reduce heat stress while providing agent protection to the wearer equal to or better than current systems.

PHASE I: Exploratory development and delivery of a prototype material sample for USN evaluation. The sample shall be bonded to a piece of clear polycarbonate, simulating the actual integration of a hood to a polycarbonate optical lens. A report shall be delivered to NAWCADPAX describing the technical specifications and prior testing performed on this new material, the bonding utilized and any special bonding procedures.

PHASE II: Deliver 2 prototype hood cowls manufactured from the new material (presented in Phase I) to the US Navy for inspection and testing along with a final report. These 2 prototypes shall demonstrate that the material can be formed/shaped to the head. Laboratory evaluation results as well as critical hood cowl sizing and dimensions will be provided to the contractor for incorporation into the final developed product.

PHASE III: Start production of hood cowls incorporating the sizing and dimensions provided by the USN in Phase II and utilizing the selected new material. Initiate transition to USN/USMC rotary and tactical aircrew and similar industrial hood/masks.

PHASE III DUAL USE APPLICATIONS: This technology has great potential for use by other services, as well as for hazmat, industrial, and chemical weapon destruction personnel who will be wearing protective ensembles.

KEYWORDS: Chemical/Biological, protective material, CBW mask, impermeable, heat stress

CBD98-204 TITLE: Integrated CBW Flight Glove

CATEGORY: Advanced Development

KEY TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Develop an integrated CBW protective flight glove that provides protection equal to or better than the current three glove system and provides higher tactility.

DESCRIPTION: Current CBW protective flight handwear consists of three pairs of gloves: an inner cotton liner glove for comfort and perspiration absorption, a 7 mil butyl rubber glove for agent protection and a nomex flight glove for fire protection. These three pairs of gloves when worn together are very bulky and cumbersome making it very difficult to perform aircrew tasks that require high tactility, such as depressing small buttons and switches. Therefore, a new integrated glove is sought that would replace the current 3-glove system thus enhancing dexterity and providing high tactility. This new integrated flight glove shall provide CBW agent and fire protection equal to or better than current protective handwear.

PHASE I: Evaluate current state-of-the-art CB flight glove ensemble technology. Develop and recommend an integrated glove for use by aircrew and submit material samples. A report shall be delivered to NAWCADPAX on the recommended design concept.

PHASE II: Perform detailed design and development and deliver 6 pair of gloves to the US Navy for testing by

NAWCADPAX along with a final report.

PHASE III: Start production of gloves and initiate transition to USN/USMC rotary wing and tactical aircrew.

PHASE III DUAL USE APPLICATIONS: This technology has great potential for use by other services, as well as for hazmat, industrial spill, and chemical weapon destruction personnel who require protective ensembles.

KEY WORDS: CBW, flight glove, protective, high tactility

CBD98-205 TITLE: CBW Ensemble Protective Coating

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Exploratory Development

OBJECTIVE: Develop a Chemical/Biological Warfare (CBW) protective coating that can be applied on site to an entire aircrew ensemble (except for the optical area) prior to flight which will increase the level of protection when exposed to a contaminated environment. The coating shall not interfere with the operation or function of any man-mounted equipment. When applied to aircrew clothing and life support equipment it shall be quick drying and act as a liquid agent repellent. Once applied, the coating shall allow for release of heat and sweat vapor, be fire resistant, and enhance decontamination procedures. Ideally, this protective coating would be sprayed on immediately prior to a CBW mission.

DESCRIPTION: Current CBW ensembles consist of multi-layers of protective clothing as well as man-mounted equipment, i.e., torso vests, restraint harnesses, survival vests, blower units, pouches, pockets, etc. Much of the ensemble, that can't be laundered, is difficult if not impossible to decontaminate. Applying a protective coating to the complete ensemble including mask would increase the level of protection during exposure to CB agents and make it easier to decontaminate after exposure. Ideally, decontamination would consist of a brisk hose down with water to wash off all contaminants settled upon the repellent coating.

PHASE I: Exploratory development and delivery of a sample of liquid/aerosol for USN evaluation in the laboratory. A report shall be delivered to NAWCADPAX specifying the active ingredients and other pertinent technical information.

PHASE II: Finish development and thoroughly test protective coating. Deliver an ample supply of liquid/aerosol spray to coat a minimum of 12 aircrew ensembles to the US Navy for inspection and testing, along with a final report. This supply shall demonstrate that the ensembles can be quickly sprayed prior to flight and that it will increase the level of protection during agent exposure and make it easier to decontaminate following exposure.

PHASE III: Start production and initiate transition to all services and similar industrial protective ensembles.

PHASE III DUAL USE APPLICATIONS: This technology has great potential for use by other services, as well as for hazmat, industrial spill, and chemical weapon destruction personnel who require protective ensembles.

KEY WORDS: CBW, protective coatings, repellent, decontamination, aerosol spray

CBD98-206 TITLE: Development of a Universal Chemical/Biological Decontamination System

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Advanced Development

OBJECTIVE: Develop a universal chemical/biological (CB) warfare agent decontamination system to be used in response to a chemical attack on joint military aircraft.

DESCRIPTION: The CB threat potential for military personnel and civilians is increasing at an accelerated pace throughout the world. Consequently the need for a universal decontamination system for the joint US forces is of vital importance. The

decontamination system must be effective in neutralizing the G, V, and H family of chemical agents. The decontamination system as well as any by-products generated during chemical reactions with the chemical agents must be non-corrosive, non-toxic and non-hazardous to personnel and equipment. The development of a delivery system should take into account the fluid transport and mixing properties of the decontamination fluid to ensure effective application.

PHASE I: Conduct an extensive literature search on agent chemistry, toxicology, and potential decontamination technologies for GB, GD, thickened GD, VX, HD, and thickened HD. Identify, evaluate, and rank the best technical approach for the development of a decontamination system which will neutralize the listed agents individually or in combination on contaminated US military personnel and equipment. The neutralization of the chemical agents must meet decontamination requirements as described in the NBC Contamination Survivability Criteria for Army Material.

PHASE II: Develop a live agent test plan to verify capability of the decontamination system. Develop and test delivery system concept for the decontamination system. Evaluate decontamination system using live agent tests on specified military coupon surfaces. This testing will provide the following data, a) kinetic study of the decontamination system to determine the reactivity of the decontamination system for each of the chemical agents b) mass balance on all coupon tests to account for all the mass of the agent used in the tests, c) pH analysis of the decontamination system, d) corrosion testing to examine the effects of the decontamination system on the coupon surfaces, e) shelf life studies on the decontamination system. The feasibility of the proposed decontamination technology shall be demonstrated by performing laboratory tests with live agent simulants and with live agents.

PHASE III DUAL USE APPLICATIONS: A multitude of military and commercial applications exist for the use of a universal decontamination system. In recent years there has been a proliferation of CB threats in military conflicts and in terrorist activities. The primary applications will involve the effective decontamination of physical structures both in the military and civil arena.

REFERENCES: NBC Contamination Survivability Criteria for Army Material, August 12, 1991.

KEYWORDS: decontamination system, delivery system, CB threat, simulants, chemical agents, live agent tests.

CBD98-207 TITLE: CBW Safe Water Pouch

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: Advanced Development

OBJECTIVE: Develop a Chemical/Biological Warfare (CBW) hardened water pouch that is small, lightweight, soft, and flexible which will fit into an aircrew overvest and provide hydration for aircrew during flight operations in a contaminated environment.

DESCRIPTION: Current tactical aircrew utilize a water canteen as a source of hydration during pre-flight and post flight only. They do not carry a source for hydration in-flight because there is no real estate available within the cockpit to store the canteen. There is also an imminent hazard should the aircrew have to eject. Reducing the bulk and weight of the current canteen to a soft pouch will allow the aircrew to store it in an overvest pocket. This would allow the aircrew to hydrate themselves in-flight and precludes the risk of injury during an ejection. The proposed chemical hardened water pouch shall integrate with current CBW respirator ensembles.

PHASE I: Evaluate proposed sources and recommend and develop a system for use in a CBW contaminated environment. A report shall be delivered to NAWCADPAX with the recommended system.

PHASE II: Perform detailed design and development and deliver 6 chemical hardened water pouches to the US Navy for testing by NAWCADPAX along with a final report. Laboratory evaluation results will be provided to the contractor for incorporation into the final developed system. Integration with current aircrew life support systems will also be verified.

PHASE III: Start production of chemical hardened water pouches and initiate transition to USN/USMC tactical aircrew and into other services and similar industrial applications.

PHASE III DUAL USE APPLICATIONS: This technology has great potential for use by other services, as well as for hazmat, industrial spill, and chemical weapon destruction personnel who require protective ensembles.

KEY WORDS: CBW, water pouch, hydration, man-mounted

CBD98-301 TITLE: RNA Probe Methodology for Microorganism Biodetectors

KEY TECHNOLOGY AREA: Chemical and Biological Defense

CATEGORY: 6.1 or 6.2 Exploratory Development

OBJECTIVE: To develop the methodology of fluorescence based RNA probes to identify and quantify microorganisms including bacterial spores and animal virions collected from an aerosol in a very short time.

DESCRIPTION: Fluorescence based RNA probes have been developed for various microorganisms. A method is needed to incorporate such a probe into a system which can detect the presence of one or all of a list of several target microorganisms. It should also have the potential of detecting, identifying, and quantifying a very few (ten to one hundred) target microorganisms in the presence of a large background of interferrent particles (e.g. dust) which are also in the one to ten micron size range. The method must be capable of utilizing a sample collected from an aerosol with total time from collection to identification less than thirty minutes.

PHASE I: In Phase I the contractor will obtain fluorescent RNA probes and develop the methodology to demonstrate with experiments the capability described above. The method must also be shown to be capable of being incorporated into an instrument which can be operated with minimal training.

PHASE II: In Phase II, the contractor will do further experimentation to show that the method can be used with RNA based animal viruses, and a target list of microbial pathogens. A demonstration instrument incorporating the new methodology in a way which is automatable will be designed, fabricated, and experimentally characterized. A prototype device will be delivered complete with instructions in a form suitable for further laboratory or field testing.

PHASE III DUAL USE APPLICATIONS: Hospital and building Monitoring, Environmental monitoring, Medical diagnostics

KEY WORDS: RNA Fluorescent probes, Microorganism detection, Automatable Biosensors

NAVY
PROPOSAL SUBMISSION
INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper ((703) 696-8528). The Deputy SBIR Program Manager is Mr. John Williams ((703) 696-0342). If you have any questions, problems following the submission directions, or inquiries of a general nature, contact us. All Phase I proposals must be submitted to:

Office of Naval Research
ATTN: NAVY SBIR PROGRAM, CODE 362
800 North Quincy Street, RM 633
Arlington, VA 22217-5660

The Navy's SBIR program is a mission-oriented program which integrates the needs and requirements of the Navy through R&D topics which have dual-use potential. Navy SBIR topics will also fall within the DoD Science and Technology areas (listed in table 1) and the Navy Science areas. Navy topics will be funded from these areas according to a priority it has established to meet its mission goals and responsibilities. Information pertaining to the Department of Navy mission can be obtained by viewing various Navy World Wide Web sites at http://www.navy.mil. Additional information on the Office of Naval Research (ONR) and Navy SBIR Program can be found on the ONR Home Page (http://www.onr.navy.mil).

NEW THIS YEAR:

1. The Navy is now requiring Appendix E to be submitted in an electronic format along with Appendix A and B.
2. All Phase I award winners must electronically submit a Phase I Summary Report to the Navy at the end of the PhaseI effort. This requirement will also be included in Phase II contracts and is described in further detail below.
3. The Navy requires that all Phase II proposals include an electronically submitted Appendices A, B and E.
4. The dates and requirements for Navy FastTrack submissions have been modified and are described below.

PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria must be met or your proposal will be REJECTED.

1. You must use the electronic format described in the section "Electronic Submission" described below. The Navy will not accept any proposals that do not have electronic forms of Appendix A, B, and E.

2. An electronic version of Appendix E must be submitted with all proposals. Even if you have no Phase II information to report. (Electronic version of Appendix E is a new requirement this year)

3. Your Phase I proposed cost for the base effort can not exceed $70,000. Your Phase I Option proposed cost can not exceed $30,000. The costs for the base and option should be clearly separate and identified on Appendix A, the cost proposal and in the work plan section of the proposal.

4. Your proposal must be received on or before the deadline date. The Navy will not accept late proposals, if you have any questions or problems with submission of your proposal allow yourself time to contact the Navy and get an answer to your question. Do not wait until the last minute.

ELECTRONIC SUBMISSION OF APPENDICES:

There are two ways to submit your SBIR proposal to the Navy, the preferred method is the online submission. **The Navy WILL NOT accept the Red Forms in the rear of this book as valid proposal submission forms of the Appendix A, B and E or the Electronic download forms from the DOD Homepage.** Instead proposers must use **one** of the following procedures **(but not both)**. The preferred method is the Online Submission.

1. Online Submission (through the Navy SBIR Website)

A. Go to the ONR Homepage (address --http://www.onr.navy.mil), click on "Business Opportunities", then click on "Navy SBIR Online submission interface".
B. Submit your Appendix A, B and E via the Online Submission option. Just fill out all the information requested, the screen format will look different then the forms in the solicitation. Once, you have filled in the data, follow the instructions to electronically submit appendices. That is, make sure you click on the Submit button located under the file icon, which will electronically send your appendix to the Navy.
C. After you have received acknowledgment of receipt, print out and sign the Appendix A/B and E form.
D. Submit the signed Appendix A/B and E form along with one original and four copies of your entire proposal (the copies should include 4 copies of the signed Appendix A, B and E forms) to the Navy SBIR Program Office at the above address. Mark the outside of the envelope with your topic number.

2. Diskette submission

A. Obtain the Navy SBIR Appendix A, B and E program (Sbir_ab.exe). This program is available from the Navy SBIR Bulletin Board (through the Internet) or you can request a copy of it on disk from the above address (please specify the computer platform PC or Mac. Note, old Navy Solicitation disk versions do not contain the proper Appendix E form, you must request a new 98.1 Disk or obtain the form from the internet site).
B. To download this program from the Internet: go to the ONR Homepage (address --http://www.onr.navy.mil), click on "Business Opportunities", click on "Navy SBIR/STTR Bulletin Board", click on "Electronic Data Entry Forms". Click on "SBIR" under the heading for "Proposal cover sheets: Appendix A, B and E" or scroll down to the "For Macintosh Users" section for Mac versions.
C. To run the program, double-click on it in File Manager (in Windows 3.1) or Windows Explorer (in Windows '95), or for Mac versions, open it in your spreadsheet application.
D. Data enter information.
E. Save file with .dat extension.(Do not save in a word processing format)
F. Print out and sign the Appendix A, B, and E form.
G. Submit the signed Appendix A, B and E form along with one original and four copies of your entire proposal (including 4 copies of the signed Appendix A, B & E form) together with a disk containing the .dat file generated from the Appendix A, B and E program to the Navy SBIR Program Office at the above address. (Please note we do not want the entire proposal text on disk, just the Appendix A, B and E.) Mark the outside of the envelope with your topic number.

ELECTRONIC SUBMISSION OF PROJECT REPORTS:

The submission of an Electronic Phase I Summary Report will now be required at the end of Phase I. The Phase I Summary Report is a summary of Phase I results, includes potential applications and benefits, and should not exceed 750 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR Webpage at: "http://www.onr.navy.mil/sci_tech/industrial/sbir_bbs/" much like the Online submission of Appendices. If your company does not have access to the Internet on your computer consult your local library or local computer service store.

The Navy is initiating this new program to help increase the awareness and implementation of SBIR funded efforts. The goal is to increase the market potential and transition of SBIR projects by increasing the visibility and ease in accessing information about SBIR projects to DOD, government and DOD industry contacts. This should facilitate the transition of these projects into follow-on efforts and bring additional revenue to the SBIR Company.

To do this the Navy is asking companies to provide information on the status and benefits of their technology developments so that this information can be put into a media that others can easily access and review. The Navy plans to redistribute this information to a wide audience using such tools as the Navy Webpage, Accomplishment Book and a new interactive Navy SBIR Website. This will help provede parties with technical challenges or those with the need to implement new technology, with a user-friendly mechanism to access and identify SBIR companies that can provide them with solutions. This information should be **non-proprietary** yet detailed enough to provide the interested transition partner with enough knowledge to understand the potential use and benefit to their program.

NAVY FASTTRACK DATES AND REQUIREMENTS:

All Fast Track Applications and required information must be sent to the Navy SBIR Program Manager at the address listed above and to the Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC) for the contract). The following dates and information are required by the company to qualify for the Fast track program. All of the requirements listed in the Fast track Section of the front of this solicitation must be met. The information provided below provides specific dates and some additional information that is required by the Navy SBIR Program Office. The Navy may make further changes to the Fast Track procedures, incorporating the central principles of the Fast Track policy (Section 4.5), subject of the approval of the Under Secretary of Defense for Acquisition and Technology this fall. Please review the Navy Website before submitting your Fast Track application.

Party/Days After Phase I Award	**Required Deliverables**
SBIR Company / 150 Days	- Fast Track Application and all supporting information. (See instructions in the DOD section of this Solicitation) - Phase II 5 Page Summary Proposal, as is required of all Phase I projects as described in Navy SBIR Website, listed above. (It is strongly recommended that if you are contemplating the submittal of a Fast Track Application, you make your intention known to your technical point of contact (TPOC) and the SBIR Systems Command Program Manager (PM) for that respective topic. The PMs are listed on the sixth page of the Navy Introduction.)
SBIR Company /181 - 200 Days	- Phase II Proposal - Phase I Final Report
Navy / 201 - 220 Days	Navy will formally Accept or Reject your Phase II proposal.
SBIR Company /45 Days after Acceptance	Proof that Funding has been received by SBIR company.

YOUR SUBMISSION TO THE NAVY SBIR PROGRAM:

This solicitation contains a mix of topics. When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award (with the exception of Fast Track Phase II proposals - see Section 4.5). If you have been invited to submit a Phase II proposal to the Navy by the TPOC, obtain a copy of the Phase II instructions from the Navy SBIR Bulletin Board on the Internet or request the instructions from the Navy SBIR Program Office. All Phase I and Phase II proposals should be sent to the Navy SBIR Program Office (at the above address) for proper processing. If the Program Office is unaware of the proposals in the system, they can not be tracked. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I and II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. **The Navy will not accept Phase I proposals in excess of $70,000 (exclusive of the Phase I option).** The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I Option should be the initiation of the next phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("fast track" is described in Section 4.5 of this solicitation). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II); 2) a transition or marketing plan (formally called a "commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan for further R&D if the transition plan is evaluated as being successful. You must also submit your Phase II appendix A,B&E electronically to the Navy SBIR Program Office at the address above. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II Option will be limited to 40 pages (unless otherwise directed by the TPOC or contract). The transition plan should be in a separate document.

The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY AREAS	SCIENCE AREAS
Aerospace Propulsion and Power	Atmospheric and Space Science
Aerospace Vehicles	Biology and Medicine
Battlespace Environment	Chemistry
Chemical and Biological Defense	Cognitive and Neural
Clothing, Textiles and Food	Computer Sciences
Command, Control and Communications	Electronics
Computers, Software	Environmental Science
Conventional Weapons	Manufacturing Science
Electron Devices	Materials
Electronic Warfare	Mathematics
Environmental Quality and Civil Engineering	Mechanics
Human-System Interfaces	Ocean Science
Manpower, Personnel and Training Systems	Physics
Manufacturing Technology	Terrestrial Sciences
Materials, Processes and Structures	
Medical	
Sensors	
Surface/Undersurface Vehicles/Ground Vehicles	
Modeling and Simulation	

NAVY SBIR PROGRAM MANGERS OR POINTS OF CONTACT FOR TOPICS

TOPIC NUMBERS	POINT OF CONTACT/ACTIVITY	PHONE
N98-001 to N98-010	Mr. Douglas Harry (ONR)	703-696-4286
N98-011 to N98-018	Mr. Joe Johnson (MARCOR)	703-784-4801
N98-019 to N98-066	Ms. Carol VanWyk (NAVAIR)	301-342-0215
N98-067 to N98-128	Mr. William Degentesh (NAVSEA)	703-602-3005

NAVY SBIR 98.1 SOLICITATION
WORD/PHRASE INDEX

DEPARTMENT OF NAVY
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
SOLICITATION 98.1 TITLE INDEX

OFFICE OF NAVAL RESEARCH

MARINE CORPS

NAVAL AIR SYSTEMS COMMAND

N98-038	Low-latency, Protocol Independent, Network Interfaces for Advanced Avionics Systems
N98-039	Pulse Detection Electronic Hardware for Multi-discriminant Laser Radar
N98-040	Weapon System Operator Tactical Operation Aids
N98-041	Low Cost, Light Weight Optics For Improved Multi-Function EO Sensor Performance
N98-042	Environmentally Adaptable Detector/Classifier
N98-043	Advanced SAR Techniques Including UWB/UHF for Mine and Unexploded Ordnance Detection/Classification
N98-044	Innovative signal detection for impulsive-source active sonar systems operating in shallow water
N98-045	Low Cost Adaptive Optics for Commercial and Military Systems
N98-046	Embarked Aircraft Tracking System (EATS)
N98-047	Passive Target Velocity Measurement System
N98-048	High Bandwidth, Secure, Portable, Wireless LAN
N98-049	Portable Ground Based Solid State IFF Situation Display System
N98-050	Corrosion Avoidance Materials
N98-051	Electronic Schematic Archive
N98-052	Non-Cadmium Brush Touch-up Process for Cadmium Replacements (IVD Aluminum, Zinc Alloys, Molten Salt) Repairs
N98-053	Develop Automatic Test System (ATS) Analysis and Configuration Management Tool
N98-054	A Tool for Forecasting Training Requirements by Simulation
N98-055	Computer-based Training Conversion System
N98-056	Helicopter Weapon System Emulation Model
N98-057	Advanced Training Technology Delivery System
N98-058	Imagery Database Retrieval and Indexing
N98-059	Interactive Part-Task Training Over Local Area Networks (LANs) and the Internet
N98-060	New Techniques for Compiling Multiresolution Terrain Representations
N98-061	Real-time High Fidelity Image Synthesis for Virtual Reality-Based Trainers
N98-062	Aluminum Nitride Infrared Window
N98-063	Durable, Transparent, Electrically-Conductive Coatings
N98-064	Low-Cost, High-Fidelity, Portable UCAV Simulation
N98-065	Accelerometer-Based Multi-Sensor INS
N98-066	Shape Charge Warhead Effectiveness Simulation, Including the Resultant Effects when Coupled with Current Shaped Charge Countermeasures.

NAVAL SEA SYSTEMS COMMAND

N98-067	Wideband Fine Frequency Measurement
N98-068	Real Time Software Upload/Download via Satellite
N98-069	Low-Cost Nozzle Throat for High-Performance Tactical Missiles
N98-070	Active Antenna Design Concept Using Microwave Power Modules
N98-071	Robust Adaptive Target State Estimation for Missile Guidance
N98-072	Combat System Software Migration to Open Systems
N98-073	Low-Cost, Non-Rayon Carbon-"Phenolic" Composites for Rocket Nozzle Applications
N98-074	Development of low-cost X-band T/R modules with commercial off-the-shelf components.
N98-075	Low Cost Manufacturing of Lightweight Resin-Matrix Composites
N98-076	Improvements in Microwave Power Modules
N98-077	A Multi-Level Network (MLN) Approach to Theater Battle Management Operations
N98-078	Compact High Energy Infrared Laser
N98-079	PCMCIA Card to Collect/Store Vibration/Performance Data for Operating Machinery.
N98-080	Hover-Craft (LCAC) Vehicle Dynamics
N98-081	Variable Virtual Combat Mock-up (VVCM)
N98-082	Reconfigurable Computing

N98-083	Non-intrusive, non-mounting, non-contacting hand held Vibration Data collector, storage and analysis system for Operating Machinery
N98-084	Development of a Registration Mine Capability
N98-085	Virtual Integrated Engineeering Data Extraction Environment
N98-086	Cleaners for Wastewater Ultrafiltration Membranes
N98-087	Modulated Scattering Technique (MST) Field Probe Array System (FPAS) for Rapid Near-Field Measurements of Antennas and Composite Walls
N98-088	Co-Infusion of Multiple Resin Systems Through the Thickness for Composites Structures with Enhanced Fire Performance
N98-089	Development of a Low Cost Process to Provide Improved Carbon Fiber-Vinyl Ester Adhesion
N98-090	Automated Mechanism for Transfer of Unclassified Information Residing in Secret Environments into Unclassified Environments Using Intermediate, Multi-Level Databases
N98-091	Quieting inflow to enclosed impellers and/or open field propellers for acoustic silencing
N98-092	Shipboard Airborne Noise Control Design and Diagnostic Tool
N98-093	Biofouling and Biocorrosion Monitor
N98-094	Affordable High Performance Reinforced Polyurethane Shock and Vibration Mounts
N98-095	Red Phosphorous Powder Manufacturing Process
N98-096	Non-skid Surface Coatings for Navy Fleet Applications
N98-097	Fiber Optic Link Simulator
N98-098	Injection Molded Ceramic Ferrules for Fiber Optic Connectors
N98-099	Dynamic Firing Zone for Weapon Systems
N98-100	Self-Routing in Photonic Packet Switching
N98-101	Corrosion Prevention and Control for Out Board Submarine System
N98-102	Monopropellant Fuels
N98-103	Universal Acoustic Sensors for Acoustic Sonar Arrays
N98-104	Embedded Intelligent Tutoring Systems
N98-105	Tunable Vibration Absorber for Small, Underwater Vehicles
N98-106	Acoustic Interference Rejection
N98-107	SC 21 Smart Product Model (SPM)
N98-108	Grabber for Ordnance Handling Robot
N98-109	Control Approach for Heavy Payload Handling Robots
N98-110	Rugged, Portable Ground Station for NSFS Targeting
N98-111	NAVARM Naval Range Extender for Army Artillery Shells
N98-112	Small, Rugged Internal Combustion Engine
N98-113	Robotics - Develop Manipulators To Handle Various Types of Manufacturing Processes
N98-114	Advanced Technologies Leading to Condition Based Maintenance
N98-115	COTS Approach to Information Security
N98-116	Compact Sensor for Measuring Large Strains on the Surface of Elastomers
N98-117	Combat System Testing & System Integrity Assessment Tools
N98-118	Plasma Antenna For Type 18 Periscope
N98-119	Use of Common Object Request Broker Architecture (CORBA) to Control Classified Data Distribution
N98-120	Plug and Play Adjunct Processing To Support Rapid Technology Insertion
N98-121	High Power Switching for MF Active Sonar Aperture Selection
N98-122	Low Cost COTS Replacement for Versa Module Europe (VME) Chassis Computing Systems
N98-123	Low Cost Hydrophone Manufacturing & Assembly
N98-124	Sonar Performance Enhancement in the Littoral Environment
N98-125	Optimized Laser Scanning Doppler Vibrometer for Measurements on Rotating Propellers in Water
N98-126	Combat Systems COTS System Administration
N98-137	Next Generation Combat System Display Concepts
N98-128	Migration of Advanced Development and COTS Applications to Tactical Operating Environments

DEPARTMENT OF THE NAVY
98.1 SBIR SOLICITATION TOPICS

OFFICE OF NAVAL RESEARCH

N98-001 TITLE: Technology for Affordability

OBJECTIVE: The objective of this project is to develop innovative technologies that will reduce the costs of manufacturing and or repair/remanufacturing aircraft, rotorcraft, ships, submarines, weapon systems or components. These methods or processes will reduce the life-cycle costs of the system, but not adversely impact performance. Areas of interest include but are not limited to materials, electronics, metalworking, composites, joining, and eletro-optics.

DESCRIPTION: There is a need to improve the affordability of new Navy weapon systems and develop cost effective methods to sustain existing and aging Navy weapon systems. Affordability has become a major consideration in all aspects of the life-cycle of Navy systems. Technologies that will allow the Navy to economically acquire new weapon systems and maintain these systems in operation and provide for the upgrade of these systems with modern technologies will make life-cycle costs more affordable. At the present time the manufacturing and engineering sectors of the country have been slow to transition new developments into production. Proposals are sought that will transition these developments so they will provide benefit to the Navy and commercial industry. Efforts that have impact above the factory floor are also of interest i.e. supply chain integration, lean/agile practices design, six sigma manufacturing, integrated product and process development, manufacturing processes/fabrication maturation, and advanced industrial practices (e.g., benchmarking and best practices--technical and business, etc.) Proposals should specifically describe the technology, how it will be developed, its estimated benefits and how it would be transitioned. A minimum of three Phase I awards will be made.

PHASE I: Identify improvements to be developed, and detail where and why they will be effective.

PHASE II: Choose one of those improvements, develop a working model/prototype, and demonstrate its performance characteristics. Develop a commercialization (Phase III) plan, including descriptions of specific tests, evaluations and implementations to be performed.

PHASE III: Implement the Phase III plan developed in the second Phase.

COMMERCIAL POTENTIAL: Private sector applications and benefits must be inherent in the objective of the proposed effort.

REFERENCES:
1. The Navy ManTech Homepage is at " http://www.onr.navy.mil/sci_tech/industrial/#mantech"

KEY WORDS: Affordability; maintainability; manufacturing; six sigma manufacturing; integrated process and product development; processes; benchmarking; and best practices.

N98-002 TITLE: Advanced Comprehensive Distributed Simulation Support for Battlespace Environment

OBJECTIVE: Develop innovative Modeling and Simulation (M&S) technology for managing the full life cycle of distributed interactive simulations.

DESCRIPTION: The Modeling and Simulation (M&S) community has adopted the High-Level Architecture (HLA) as a standard to provide the infrastructure to support distributed simulation. While the HLA provides the mechanisms for interoperability, higher level coordination capability is needed for activities involved in the creation, execution, and management of distributed simulations. For example, to build and execute a simulation, it is necessary to browse existing simulation assets, integrate them into a scenario development environment, construct an exercise, initialize simulation parameters, and then commence, monitor, and manage the distributed simulation. This effort will innovate advanced technology to develop an Integrated Battlespace Environment M&S coordination manager.

PHASE I: Develop an architecture for a prototype system. Investigate existing military simulation resources as participants in a prototype system. Develop the prototype system to integrate assets into a scenario development environment, construct an exercise, initialize the participants and perform basic simulation management for the exercise operating in the context of the HLA.

PHASE II: Enhance prototype into an initial operational system that includes additional elements of HLA Run-Time Infrastructure (RTI) services. The additional services will provide more control for initialization and management of multiple distributed simulation participants. The initial system should support integration of joint simulation assets from different branches

of the military.

PHASE III: Integrate, apply and transition prototype into a large scale Modeling & Simulation and training programs.

COMMERCIAL POTENTIAL: There is significant opportunity for dual use applications in the M&S area. Typical M&S technologies include 3D visualization of simulations, and distributed communications and networking. The tools, prototypes, and research developed under this topic will be applicable to the commercial sector in areas of planning and scheduling, networked gaming, medical visualization and training, and other scientific simulation (such telephony).

REFERENCES:
1. Department of Defense; High Level Architecture Object Modeling Template Version 0.3 Defense, Modeling and Simulation Office. Alexandria, VA. May 1996
2. Department of Defense; High Level Interface Specification (Version 0.4) Defense, Modeling and Simulation Office, Alexandria, VA.

KEY WORDS: Modeling, Simulation, M&S, High Level Architecture, HLA

N98-003 TITLE: Advanced High Pulse Repetition Frequency Radar Modulator

OBJECTIVE: Design and build a radar power supply/mod-anode-pulsed modulator capable of switching a 20 Kilovolts modulating anode at a Pulse Repetition Frequency (PRF) of 100 KHzor higher.

DESCRIPTION: High power millimeter wave RF amplifiers such as gyroklystrons are capable of producing kilowatts of peak power, even at millimeter-wave frequencies. Present development efforts of high average power versions of gyroklystron amplifiers should deliver 80 kW peak and 10 kW average power at W-band frequencies. At the present time, gyroklystrons under development utilize modulating anodes for beam control; these mod-anodes generally require high modulating voltages (e.g. from -2 kV to up to +20 kV relative to the cathode potential, which is generally -50 to -65 kV). Though such tubes can in principal support high Pulse Repetition Frequencies (PRF's), the maximum PRF of the system is usually limited by the modulator, which must switch tens of kilovolts at the PRF rate. Current modulator technology can only achieve switching rates of approximately 10 KHz at these high voltage levels. In addition, demanding requirements on phase noise require tight regulation on both mod-anode voltage and cathode voltage (typically only a few volts RMS ripple or better) in order to meet radar requirements. These challenges are formidable. However, recent advances in high power solid state switches such as Insulated-Gate Bipolar Transistors (IGBT's) and all-solid-state magnetic switches make possible new modulator topologies which can produce switching rates exceeding 100 Khz. Additionally, advances in tetrode based modulator technology make possible high PRF non-solid-state modulators. This task will involve designing and building a high PRF (100 KHz or greater) modulator for use in the 10 kW average power gyroklystron-based radar being developed by the Naval Research Laboratory. The Naval Surface Warfare Center Dahlgren Division has interest in high PRF gyroklystron-based radar for ship self-defense applications.

PHASE I: Design a modulator, including power supply, capable of switching the control voltage of NRL's gyroklystron amplifier at a PRF of 100 KHz or greater. The best design will be able to switch the required control voltage at the highest rate. NRL personnel will be consulted during the design process to ensure that the final design is fully compatible with the gyroklystron.

PHASE II: Build the modulator and power supply designed in Phase I and perform testing to verify that the modulator meets the design objectives. Additionally, determine the maximum PRF rate of the modulator through testing.

PHASE III: Develop vacuum electronic-based radar system application(s).

COMMERCIAL POTENTIAL: This modulator would be useful in applications where large voltages must be switched at speeds exceeding 10 KHz, such as a modulator for medical Linear Accelerators (LINACS) used in X-Ray machines for cancer therapy. Other possible commercial applications include materials processing and civilian radars.

REFERENCES:
1. "High-Power Microwave-Tube Transmitters," William North, Los Alamos NL,Report LA-12687-MS, 1994, US DOE Off. Scientific and Technical Information.(Distribution of this report restricted to U.S. only).
2. "High Power Microwave Sources," Granatstein and Alexeff (Artech House),and the papers in IEEE Trans. on Plasma Science, Vol. 24, No. 3, June 1996 special issue on high power microwave generation.

KEY WORDS: High-Power Modulators; Gyroklystrons; Insulated-Gate Bipolar Transistors (IGBTs); Radar; High Pulse Repetition Frequencies (PRFs); tetrode

N98-004 TITLE: Acousto-optic (AO) Near Infrared Beam Deflector

OBJECTIVE: To develop a two-dimensional (2D) near infrared (IR) beam deflector with wide input angular bandwidth at 1550 nanometers (nm), preferrably, for an automatic target/image recognition (ATR) or a phased array antenna (PAA) system.
DESCRIPTION: Most of the current AO beam deflectors use visible light, and are also limited to parallel light beam input. This 2D deflector must be capable of scanning beam up to 10 degrees off the undiffracted beam. It must handle a large angular input beam width of plus or minus 5 degrees, which is above the present technology. It also has a large time-bandwidth product (>1000), large rf bandwidth (35 - 65 MHz), and the associated optical aperture size (10mm x 25mm) with from 20% to 30% diffraction efficiency at 1550 nm. This kind of 2D beam deflector combined with other optical elements will be used as a image processor with a few microseconds response time. Applications include image scanning, image processing, and automatic target/image recognition for an ATR system, a periscope system, and the next generation phased array antenna system. Compact configuration is preferable.

PHASE I: The improved concept of 2D AO beam deflector and proof of device performance are required, including a small scale demonstration of the device.

PHASE II: Develop, fabricate, and test a full-scale device satisfying the specifications above for the potential system applications determined by Phase I. System applications will be in ATR and/or PAA systems.

PHASE III: Show system potential toward specific systems such as an ATR and/or a PAA system.

COMMERCIAL POTENTIAL: ATR and PAA systems pertain to production line inspection and fast light scanning applications.

REFERENCES: "Acousto-Optic Devices", Z. Xu, John Wiley & Sons, 1992

KEY WORDS: Acousto-optic, Beam Deflection, Spectrometer, Wavelength Division Demultiplexing, Phased Array Antenna, Fiber Optical Communication

N98-005 TITLE: Long Life, Primary, Fused Salt Batteries for Pulse Power Applications

OBJECTIVE: Advance the performance of fused salt batteries in A-size systems requiring very high power pulses for at least four hours.

DESCRIPTION: The lithium/sulfur dioxide (Li/SO2) battery is the Navy's workhorse power supply for sonobuoys. Employed in antisubmarine warfare (ASW), sonobuoys are generally A-size, meaning roughly 38 inches long and 4 7/8 inches in diameter, and air deployed. The battery must occupy a minimum weight and volume. For such use, Li/SO_2 offers the best presently available combination of high power and energy at affordable cost. However, changes in the ASW arena, have driven an exponential increase in pulse power for future sonobuoys while retaining the need for low weight and volume and at least a four hour operating life. Recent developments in thermal batteries have provided 4.2 kW, for 200 seconds over two hours of operation in a battery weighing 13 pounds and occupying 10 inches of the sonobuoy length. Further developments in fused salt batteries can provide a minimum power of 4.6 kW at a min mum of 50 V, for 150 - 200 seconds, with an operating life of at least four hours. Such a battery could weigh 10 pounds and occupy 8 inches of sonobuoy length, or less. This level of performance will require component optimization such as: long life separators, ultra high performance insulation, bipolar stack edge seals, etc. These combined advances would spin-off enhanced ASW performance for countermeasures and A-sized targets, as well as numerous weapons, missiles, and munitions.

PHASE I: Design a fused salt battery for future sonobuoys. Evaluate pulse power, number of pulses, and operating life, relative to physical size and weight (including all ancillary components) of the battery. These include all additions to the battery to ensure safe operations in the buoy, or the deployment platform, and in storage. Demonstrate on a small scale, such as single cells.

PHASE II: One or more specifications will be provided for a high performance battery. Batteries will be demonstrated in bench top testing.

PHASE III: Further development of battery technology for an advanced sonobuoy and for quiet electric and/or hybrid electric vehicles for forward military deployment (Humvee, Swimmer Delivery Vehicle, Unmanned Vehicles—Air, Ground, Water Surface, and Underwater).

COMMERCIAL POTENTIAL: The development of this technology as a primary (non-rechargeable) battery is a natural foundation for the increased complexity inherent in rechargeable batteries. This foundation will logically lead to rechargeable batteries for electric and hybrid electric vehicles for civilian use (e.g., lawn mowers, mopeds, cars, and buses).

REFERENCES:
1. Handbook of Batteries and Fuel Cells, D. Linden, ed., McGraw-Hill, New York, 1984.

2. "Design and Performance of High-Power Long-Life Thermal Batteries," N. Papadakis et al, 37th Power Sources Conference, Cherry Hill, NJ, 1996
3. "Sonobuoy Battery Development," P.B. Keller et al, 37th Power Sources Conference, Cherry Hill, NJ, 1996

KEY WORDS: Thermal Battery, Molten Salt Battery, Fused Salt Battery, Sonobuoy

N98-006 TITLE: Waterproofed MEMS-Based Conformal Shear Stress Sensors

OBJECTIVE: Develop a thin, flexible, waterproofed, MEMS-based shear stress sensor for use on small and large-scale Navy vehicles in a freshwater environment.

DESCRIPTION: An array of waterproof and flexible MEMS based shear stress sensors would greatly enhance our evaluation of flow characteristics about model hulls and control surfaces. If the transition, separation, and turbulence characteristics are known, they can assist in evaluating the hydrodynamic merit of a new design and, perhaps more critically, in validating computational fluid dynamics (CFD) methods. A thin and flexible MEMS based sensor could provide high resolution, and extremely sensitive shear stress data about curved surfaces. Such devices could be installed flush mounted without milling matching sensor cavities or pits. The devices must survive total freshwater submersion for about 8 weeks and withstand total pressures of about 2 atm. Ideally, an array of such sensors could be packaged for easy mounting and re-use about a model or control surface. Ultimately the system should be deployable for longer periods in salt water. No access to classified information is required by the contractor.

PHASE I: First, conduct analysis of projected MEMS performance to verify that the application is viable in principle. Demonstrate proof-of-concept for waterproofing techniques on a MEMS sensor and validate the capabilities of a flexible MEMS shear stress sensor.

PHASE II: Deliver a satisfactory waterproofed flexible shear stress sensor with 2-D capabilities (direction and magnitude) and install an working array of sensors on a Navy radio-controlled submarine model (RCM) at the Naval Surface Warfare Center Carderock Division (Bethesda, MD).

PHASE III: Validate the sensor array and increase the robustness of the packaging techniques for a variety of platforms.

COMMERCIAL POTENTIAL: Industries which will benefit include aerospace, automotive, chemical and manufacturing groups who perform critical flow evaluations and monitoring.

REFERENCES:
1. Jiang, F., Y.-C. Tai, K. Walsh, T. Tsao, G.-B. Lee, and C.-M. Ho, A Flexible MEMS Technology and its first application to shear stress sensor skin.
2. Jiang, F., Y.-C. Tai, B. Gupta, R. Goodman, S. Tung, J.-B. Huang, C.-M. Ho, A Surfaced-Micromachined Shear stress imager.
3. C.-M. Ho, S. Tung, G.-B. Lee, Y.-C. Tai, F. Jiang, and T. Tsao, MEMS - A Technology for Advancements in Aerospace Engineering, AIAA 97-0545, January 1997.

KEY WORDS: MEMS; shear stress measurements; miniature shear stress sensors; waterproof; flexible

N98-007 TITLE: A Polymeric Hose Health Assessment Device

OBJECTIVE: Develop a device for quickly and economically assessing the remaining life or health of a polymeric hose in place.

DESCRIPTION: Polymeric hoses used in hydraulic systems, cooling water routing, and myriad other high and low pressure applications are common on Navy ships and aircraft, but there is currently no reliable way to assess their health. A simple, quick, and inexpensive method for nondestructive testing of hose integrity is needed as a maintenance tool. The device should be able to detect impending fractures, development of thinned regions, and similar hose flaws, and provide a "red light/green light" datum for replacement or continued service. The device should be portable, hand operated, and small enough to concentrate the inspection in the areas near attachment points where hoses typically fail. Computerized systems, systems requiring extensive data analyses to make a replacement decision, or use of complex scanning systems are all undesirable for their size and/or potential operator training requirements. The target operator is a Navy E-3 or E-4 in the engineering rates.

PHASE I: Determine the basic physics of nondestructive detection of flaws in polymeric hose materials. Demonstrate the feasibility of converting this technology into a simple, hand held hose inspection device.

PHASE II: Develop a working prototype hose health assessment device. Conduct laboratory scale tests on a variety of hose materials and sizes with known flaws in various locations. Evaluate device performance in terms of overall success in detecting

different types of flaws (i.e., thin spots, impending fracture areas, etc.). Establish database relating flaw detection success rate to type of flaw and hose parameters.

PHASE III: Under program office or industry sponsorship, conduct tests on a variety of hose types and uses within the fleet. Testing should be carried out on ships, submarines, and aircraft to demonstrate detection rate in field environments. Device performance on selected commercial systems will be demonstrated.

COMMERCIAL POTENTIAL: A hand-held hose health device with proven performance capability will have immediate application commercially. The aircraft industry will benefit in time and cost savings, as well as increased passenger safety. Another application will be the automotive repair industry, where health of radiator, power-steering, brake-line hoses can be quickly determined. Other applications will also be identified if the device can be supplied at reasonable cost.

REFERENCES:
1. Favro, L. D., Kuo, P. K., Thomas, R. L., "Thermal Wave Imaging of Composites and Polymers," Proceedings, Society of Photo-Optical Instrumentation Engineer Conference, April 1994.
2. Haddad, Y. M., Molina, G., "An Acousto-Ultrasonic Pattern Recognition Approach for the Characterization of the Mechanical Response of Engineering Materials," Proceedings, American Society of Mechanical Engineers and American Petroleum Institute, Energy Week Conference, January 1996
3. Eighth (and prior) "Symposium of Nondestructive Characterization of Materials," Hosted by Johns Hopkins University Center for NDE, in Boulder Colorado, June 15-20, 1997.

KEY WORDS: hose health, hose inspection, hose integrity

N98-008 TITLE: Low Velocity Initiation Ram Accelerator Concepts

OBJECTIVE: To develop and demonstrate concepts techniques to reduce the starting Mach number associated with Ram Accelerator guns.

DESCRIPTION: Ram accelerator guns have been shown to have the potential to propel projectiles to speeds in excess of 3 km/sec. However practical use of such guns as weapons deployed on Navy ships requires that gun barrel length be constrained to practical length, typically 70 calibers or less. In a Ram accelerator, propellant gases are loaded into the gun tube. The projectile is designed so that as a result of its shape, the void between the projectile outer walls and the gun tube forms a naturally moving inlet to the propellant gases. Shock heating and compression ignites the propellant gases, which then produce thrust. Starting of this inlet, generally requires inlet entrance Mach numbers of approximately Mach 3. As a result, an alternative high acceleration mechanism is needed to boost the projectile to the inlet start speed. Current Ram accelerator efforts in the Navy utilize a hybrid combination of solid propellant gun and launch tube combined with Ram accelerator barrel extension. Reduction of the Ram starting mach number is desired to minimize total barrel length.

PHASE I: The phase 1 effort will conduct surveys and analysis of innovative concepts to be demonstrated in phase 2. Approaches to reducing the starting mach number include: use of alternative gas mixtures, innovative gas injection techniques, alternative inlet and combustion initiation mechanisms. The contractor will analyze implications of methods to practical design of navy projectiles.

PHASE II: The contractor will demonstrate low velocity start with shots of small scale projectiles. These shots will demonstrate initiation of thermally choked propulsion mode.

PHASE III: In Phase III, the contractor will very performance by detailed design and fabrication of the projectile and will demonstrate performance through firing of a full scale projectile.

COMMERCIAL POTENTIAL: Hypervelocity light gas guns such as the Ram accelerator have potential to deliver commercial payloads into low earth orbit at costs that are a fraction of conventional rocket propulsion.

REFERENCES:
1. D. Kruczynski, F. Liberatore and M. Nusca; An Analysis of Ram Acceleration for Specific Naval Applications, ARL-TR-1073, April 1996
2. Hertzberg, A., Bruckner, A.P. and Bogdanoff, D.W., Ram Accelerator: A New Chemical Method for Accelerating Projectiles to Ultrahigh Velocities, AIAA Journal, Vol 26, 1988, pp195-203.
3. Tidman, D. A.,and Massey, D.W.; Electrothermal Light Gas Gun, IEEE Trans. Mag. Vol 29, pp. 621-624, Jan 1993.

KEY WORDS: Ram accelerator, gas generator, light gas gun

N98-009 TITLE: High-Rate Single-Event Combustion Diagnostics in Electromagnetic Interference Environments

OBJECTIVE: Develop non-invasive diagnostic instrumentation for measurement of time-dependent temperatures in single-event tests of combustible materials impacting metal targets at high speed, in the presence of high transient electromagnetic fields.

DESCRIPTION: The Navy is evaluating the rapid production of heat and gases from non-explosive sources via rapid combustion of powder materials. One method of ignition is by high speed impact of materials onto target plate configurations. In impact tests, the speed, orientation, and condition of the impacting material, as well as the post-ignition motion of metal parts can be monitored by flash radiography. The significant electromagnetic interference from the flash radiography equipment can cause disruption or loss of data from conventional low-level signal sources such as thermocouples or multiwavelength infrared detector systems. The need for rapid thermal response can dictate the use of fragile exposed thermocouple junctions that may not survive damage during the test, thereby providing only partial recording of the time-dependent temperature. There is a need for a robust, non-invasive system for measurement and recording of single-event (non-repetitive) time-dependent high temperatures over periods of microseconds to several hundred milliseconds, with measurements on the order of every microsecond or more frequent. The system would be able to function in either laboratory test chamber or outdoor field test conditions, in concert with flash x-ray diagnostics. The region of the expanding fireball to be diagnosed could be limited by the walls of a container to be approximately one foot on a side, or, in a field test, could be on the order of ten feet on a side. The system would sample a selected region of the fireball.

PHASE I: Design and develop temperature-calibrated laboratory system and demonstrate feasibility of operation in high electromagnetic noise environment.

PHASE II: Based on Phase I work, design and fabricate field test system and validate performance through transient temperature diagnoses of a series of actual combustion event field tests conducted at a selected U. S. Government test facility. Any equipment developed on this project will be the property of the U. S. Government.

PHASE III: This system or similar systems would be used in support of testing for an Advanced Technology Demonstration project scheduled to begin in FY99.

COMMERCIAL POTENTIAL: This system would find application to the diagnoses and control of electric welding processes, and to the design and diagnoses of vehicle air bags and aerospace rockets.

KEY WORDS: combustion, electromagnetic interference, missile defense, ship self defense, non-intrusive diagnostics

N98-010 TITLE: Innovative Air Inlet and Nozzle Expansion Concepts for Missiles

OBJECTIVE: To develop and validate lightweight effective inlet and nozzle concepts applicable to supersonic cruise missiles with air breathing propulsion.

DESCRIPTION: The next generation of cruise missiles may be configured without wings and other large aerodynamic surfaces in order to minimize drag, resulting in a non-axisymmetric shape. Air intakes must be well integrated with the geometry in order to achieve the required flow parameters at the engine entrance, and the requisite nozzle system must accelerate the turbojet combustor flow to match local free-stream pressure over a wide range of flight conditions without resorting in complex, heavy, variable geometry. Significant boundary layer bleed must be pioneered. An air induction system must be capable of efficiently compressing air flows at all speeds up to Mach 6. Since the preferred vehicle shape minimizes aerodynamic-control surfaces, a high degree of thrust is desired but not essential, and improved transonic acceleration of a turbojet-powered missile is of interest.

PHASE I: Feasibility studies will be conducted. Specific concepts must be identified, and details of where and why they will be effective must be provided.

PHASE II: Further analyses will be conducted and a working model/prototype will be developed. CFD-type analyses and experimental tests will be conducted, and technical plans for follow-on efforts will be developed.

PHASE III: Tests will be coordinated with related programs and Advanced Technology Demonstrations, as required.

COMMERCIAL POTENTIAL: Innovative air inlet and nozzle concepts have a world-wide market for civil and military aircraft, especially if they apply to subsonic aircraft.

KEY WORDS: Supersonic inlets, transonic accelerations, cruise missiles

MARINE CORPS

N98-011 TITLE: Lightweight Track Components for Amphibious Vehicles

OBJECTIVE: To provide high strength, low weight track and road wheel components for use in the Marine Corps' Advanced Amphibious Assault Vehicle (AAAV).

DESCRIPTION: The AAAV is the Marine Corps' next generation amphibious assault vehicle and is capable of over-the-water transit at speeds in excess of 20 knots while maintaining full land mobility. Because of this high water speed requirement, the vehicle is extremely weight sensitive and all efforts are being undertaken to reduce component and system weights. The track is a prime candidate for weight reduction efforts as it exacts an unacceptably high weight penalty on the vehicle due to the extreme conditions under which it must operate. This effort will provide the AAAV with a lightweight track system which will be impervious to corrosion, be durable, and transmit a low aural signature.

PHASE I: Perform design studies and generate conceptual designs for a lightweight, durable, corrosion resistant track system for the AAAV. Alternate materials choices are to be explored. Design information from the AAAV prime contractor will be provided to assist in the design studies. The winning contractor must demonstrate that he possesses specific knowledge on track laying vehicles and is aware of and will not duplicate previous track development efforts.

PHASE II: Perform detailed design analyses and generate detailed design drawings for the selected track system concepts. Generate test plans for track sections and full track system qualification. Fabricate track sections and full track system for testing purposes on a surrogate AAAV platform of objective weight.

PHASE III: Mass produce sufficient quantities of track for the objective number of AAAV's anticipated to be procured. Investigate retrofit to existing, fielded track-laying vehicles.

COMMERCIAL POTENTIAL: Lightweight, durable, and quiet tracks would be welcomed by the construction industry for heavy vehicle use.

KEY WORDS: Mobility; track; road wheels; composite; amphibious; material

N98-012 TITLE: Power Density Improvements for Military Power Generators

OBJECTIVE: To significantly improve the energy density of military power generation systems to achieve substantial cost savings and promote inter-service component commonality.

DESCRIPTION: The AAAV is the Marine Corps' next generation amphibious assault vehicle which will incorporate significant improvements in communications, control systems, actuation systems, and sensors. These represent a substantial power load over and beyond the capacity of existing, lightweight power generation systems. This effort will develop new generator component technologies which may be applied to existing hardware to reduce acquisition time and promote commonality.

PHASE I: Utilizing the existing M1 generator as a baseline, the contractor shall perform conceptual design studies of rotating and stationary components, cooling systems, and power electronics, with the goal of increasing generator efficiency to 85%, allowing temperature independent voltage regulation, and providing the means to drive two generators in parallel form the same source. Conceptual drawings and prototype fabrication cost estimates shall be generated.

PHASE II: Perform detailed design of the concept selected during Phase I and generate all drawings necessary for the fabrication of prototype components. Procure sufficient components to build one enhanced prototype generator including spare parts and test support hardware. Generate a test plan, assemble prototype onto test bench, and execute plan.

PHASE III: Apply the technologies developed during Phases I & II to a mass retro-fit effort of the M1 generator to be installed in the AAAV during its production run.

COMMERCIAL POTENTIAL: This system could be used to reduce the weight and volume of electric drive and hybrid-electric vehicles which are evolving into economically feasible and technically viable transportation systems.

KEY WORDS: Power; kilowatts; generator; generator; rotor; stator

N98-013 TITLE: Geo-Elliptical Phased Array Satellite Tracking System

OBJECTIVE: The development of a Phased Array antenna system that will be able to track two simultaneously elliptical geo-synchronous satellites in the X-band, C-band and KU-band SHF frequency ranges and provide UHF "SATCOM-on-the-move" for tactical satellite communications systems .

DESCRIPTION: Today's tactical satellite communications systems uses parabolic antenna systems that must be stationary in order to acquire and track geosynchronous satellites, and each antenna can acquire and track only one satellite at a time. This is unacceptable in today's highly mobile battlefield environment. Naval vessels use gyro-stabilized platforms to compensate for the movement of the ship, however, this method is to expensive for vehicle mounted satellite systems. Therefore, a system that will allow dual satellite acquisition and will provide sufficient gain to ensure satisfactory link margins, while the vehicle is "on-the-move" will greatly enhance the critical command and control communications on the battlefield. The dual satellite capability and small footprint will greatly reduce the surface required for mounting the antenna, a fact that will be of great value on board Naval vessels. This capability has the potential to be used on several mobile platforms, i.e., the SHF Tactical Advanced Range extension Terminal, Amphibious Assault Vehicles, Advanced Amphibious Assault Vehicles, HMMWV, Light Armored Vehicles, Helicopters, Fixed wing aircraft, and ships.

PHASE I: Develop state-of-the-art technology that will prove the concept of high-gain, phased array, SHF satellite antennas able to acquire two satellites simultaneously on any band combination in the X, C or KU bands. The same state-of-the art technology shall be able to provide SATCOM on the move on military wheeled or armor vehicles.

PHASE II: Build and test, using an actual prototype antenna, a phased-array, SHF antenna in the X, C and Ku bands. Antenna will be tested using the SHF Tactical, Advanced, Range extension Terminal (STAR-T) and HMMWV or armor vehicle.

PHASE III: Phase III will require military program sponsorship . For successful advance to this phase, a successful proof of concept must have demonstrated and the USMC sponsor for this SBIR effort will have coordinated transition to demonstration/validation. The contractor must support a successful Phase II transfer by maturing the product to a point for commercial consideration, including manufacturability and cost.

COMMERCIAL POTENTIAL: Commercial uses for the Phased-Array antenna in the C-band and Ku-band SHF frequency ranges is immediate. This technology will be able to satisfy commercial communications such as television stations, Cable TV companies, Down Link Stations for voice communications.

KEY WORDS: Phased-array; SATCOM; antenna; communications;

N98-014 TITLE: Disposable, Low Cost, Semi-Automatic Spotting Rifle

OBJECTIVE: Develop and demonstrate a disposable, low cost, semi-automatic rifle to be incorporated as a spotting rifle for various shoulder fired weapons.

DESCRIPTION: The current spotting system used to aim the Shoulder Launched Multipurpose Assault Weapon (SMAW) is a rifle attached to the missile launch tube and ballistically matched to the rocket being fired. The rifle must be capable, as a minimum, of meeting the present SMAW spotting rifle's hit requirement of 7.5 x 7.5 ft sq target at 500 meters. It must be semi-automatic and capable of firing up to 10 rounds. This effort may include investigation of simpler operating systems, new light weight materials, and unique manufacturing processes aimed at lowering unit cost.

The effort should include ruggidization of the unit after development of the prototype for use in field conditions or other hostile environments. Issues should also address the application of new materials to this requirement described above (e.g, advantages, limitations, tradeoffs) as well as affordability and manufacturability in production.

PHASE I: Preparation of a technical report describing the proposed rifle system including engineering details of rifle functioning, ammunition, and production approaches. The report should include alternative methods of development, tradeoffs, limitations of each alternative examined, projected performance and operational characteristics of the selected alternative. If feasible, a preliminary proof-of principle demonstration as part of the Phase I effort would be beneficial.

PHASE II: Development, demonstration, and delivery of a proof-of concept spotting rifle with ammunition suitable for demonstrating and characterizing the system.

PHASE III: Production versions of the spotting rifle for engineering test and field evaluation.

COMMERCIAL POTENTIAL: The application of cost saving materials and simplified designs that would be needed to make a disposable spotting rifle could be applied to reduce the cost of firearms for law enforcement and for others using firearms.

KEY WORDS: Firearms; sighting/ranging/spotting systems; disposable.

N98-015 TITLE: High Accuracy Azimuth Sensor

OBJECTIVE: Development and demonstration of a prototype high accuracy (nonmagnetic-based) azimuth sensor suitable for use in man-portable and/or vehicle mounted applications.

DESCRIPTION: The proposed effort should address the development and demonstration of the technology to provide a compact sensor capable of measuring azimuth to an accuracy of 0.5 degrees or better. The sensor technology being sought must be compact, low power, suitable for integration into man-portable and/or vehicle mounted systems, and capable of operating reliably in adverse field conditions. The proposed effort should address issues associated with the use of the azimuth sensor in the applications described above (e.g., inherent advantages and limitations, tradeoffs, etc.) as well as issues of manufacturability and affordability in production.

PHASE I: Preparation of a technical report describing and examining the proposed azimuth sensor technology. The technical report should include the following information: theory of operation; projected performance and operational characteristics; current state of development; and proposed technical approach. If feasible, a preliminary proof-of-principle demonstration as part of the Phase I effort would beneficial.

PHASE II: Development, demonstration and delivery of a proof-of-concept device suitable for demonstrating and characterizing the operation of the azimuth sensor technology.

PHASE III: The azimuth sensor technology being pursued could be transitioned into the USMC Target Location, Designation, Handoff System (TLDHS) Program as well as numerous other tactical systems that require highly accurate azimuth information.

COMMERCIAL POTENTIAL: In much the same way that the precise position and time information capability provided by the Global Positioning System is a widely applied dual use technology; accurate azimuth information provided by a affordable, small, low power sensor could be employed in numerous man-portable and vehicle-based military and commercial systems.

KEY WORDS: sensors; azimuth; navigation; surveillance

N98-016 TITLE: Advanced SIGINT System

OBJECTIVE: To research and develop a signals intelligence/electronic warfare system capable of conducting intercept, direction finding, and electronic attack missions from non-dedicated ground and air platforms organic to the Marine Corps.

DESCRIPTION: The Advanced SIGINT System: 1) shall be functional on a wide variety of different fixed or rotary wing airframes, to include the UH-1N, CH-46, CH-53, MV-22, and C-130, 2) shall be mountable, in a period not to exceed six hours, by squadron or Radio Battalion personnel 3) shall be readily adaptable to use in other vehicular platforms, to include the AAAV, LAV, and HMMWV 4) shall be able to conduct signals intercept operations in the HF/VHF/UHF/SHF spectrums, 5) shall be able to conduct direction finding operations in the HF/VHF/UHF spectrums, 6) shall conduct electronic attack operations in the HF/VHF/UHF spectrums 7) shall comply with all safety of flight regulations and pose no threat to the operator, 8) shall be powered by battery or vehicular power supplies, 9) shall not exceed 200 pounds, 10) shall require no structural changes to the existing platforms.

PHASE I: Identify or develop an integrated antenna system, intercept system, electronic attack system, and direction finding system, suitable for use on airborne and ground based platforms. Develop plan to integrate required functionality into a single unit, to include a technical drawing package, functional specifications, configuration criteria, costs and availability. Develop solutions to all safety of flight issues and interference cancellation problems. Provide a detailed plan of the Phase II effort.

PHASE II: Build two engineering development models and conduct developmental testing in a field environment. Collect data to verify performance capabilities and provide a final product evaluation report.

PHASE III: Phase III will require military program sponsorship. The contractor must support a successful Phase III transfer by maturing the product to a point for commercial consideration, including manufacturability and cost.

COMMERCIAL POTENTIAL: The private sector industry can benefit from this technology. To this end, there are numerous applications for the system. Helicopters being utilized by Emergency Medical Services would have an ability to monitor multiple emergency channels. The direction finding applications could be used by forestry officials in order to more effectively track firefighting resources and wildlife. Federal law enforcement agencies could make use of the full range of system capabilities.

REFERENCES:
1. Family of Collection and Utilization Systems (FOCUS) Mission Needs Statement (No CCC35)
2. Family of Lightweight, Advanced, Mobile-Mounted, Electronic-Attack Systems (FLAMES) Mission Needs Statement (No CCC 32)

KEY WORDS: multi platform; antenna; suite; portable; Electronic Warfare, SIGINT

N98-017 TITLE: Modular Remote Electronic Attack System

OBJECTIVE: Enhance the capability to conduct Electronic Attack (EA) from tactical intelligence systems organic to the Marine Corps. The Radio Battalions require the ability to utilize EA during Radio Reconnaissance Teams (RRT) special missions. Currently fielded systems have been unable to incorporate EA capability suitable to the special employment constraints of these teams. Previously, size, weight and power requirements precluded the use of EA on RRT deployments. A self-contained modular EA application that can be incorporated via wireless LAN into organic RRT intelligence gathering systems will overcome the employment issue and will extend the Radio Battalion's ability to conduct EA into the forward edge of the battlefield and during special operations. This capability will significantly enhance MAGTF electronic attack capabilities. The light-weight, remote capable, wireless LAN EA module will be capable of interfacing with the Marine Corps Radio Reconnaissance Equipment Program SIGINT Suite-1 (RREP- SS-1) system. Remote connectivity is required out to 5 kilometers. The EA module should include on-board power, remotely tunable transmitters, and remotely controlled power output.

DESCRIPTION: The modular remote EA system: 1) should be able to be controlled from the SS-1 and a variety of different fixed or mobile control stations. 2) should be deployable within a short time period by RRT, Radio Battalion, and other advance force personnel, 3) should be able to operate in the VHF/UHF/SHF spectrums, 4) should support the RRT employment concept as it relates to size, weight and power consumption.

PHASE I: Research existing EA and remote systems technologies. Investigate frequency allocation issues, software interface and other design issues that lend themselves to the alliance of the two technologies. Develop functional specifications, configuration criteria, costs and availability. Provide system design and an outline of the Phase II effort.

PHASE II: Fabrication of up to eight engineering development models capable of being tested in a field environment by users. Collect data to verify performance capabilities and provide a final product evaluation report.

PHASE III: Phase III will require military program sponsorship. The contractor must support a successful Phase III transfer by maturing the product to a point for commercial consideration, including manufacturability and cost.

COMMERCIAL POTENTIAL: The private sector industry of wireless LAN technologies and IP data transfer, as well as Other Government Agencies, can benefit from this technology. There are numerous applications for modular remote control capability systems. With the swap-out of EA with conventional transmitters, the wireless LAN and transmit control functions of the system could be adapted to anyone or any architecture that utilizes direct transmit control functions. Additional users can be provided transmit services without the cost of additional transmitters. Department of Transportation, Emergency Medical Services and law enforcement officials could have the ability to remotely activate vehicle radio and transportation monitoring equipment.

REFERENCES: Operational Requirements Document (ORD) for the Radio Reconnaissance Equipment Program (RREP) No. CCC 1.43

KEY WORDS: Electronic Attack (EA); SIGINT; remote control; LAN; man-packable

N98-018 TITLE: Air-Delivered Sensor Orientation Technology

OBJECTIVE: The objective of this topic is to develop the technology that enables Air-delivered Sensor (ADS) detection arrays to self-orient to a reference azimuth. The end result of the application of this technology is an ADS that provides information on target direction, direction of movement, and target velocity. These Air-delivered Sensors are dropped from Marine Corps/Navy high performance tactical aircraft in support of amphibious operations and expeditionary operations ashore.

DESCRIPTION: There is a requirement in the Marine Corps to orient Air-delivered Sensors. Currently, the Marine Corps has air-delivered sensor technology, however, there is an implied requirement in refining this technology to enable a sensor to determine target location, direction of movement, and target velocity.

PHASE I: Explore the application of technologies required to passively determine the direction orientation of

ground-embedded sensors after they have been dropped from tactical aircraft. This technology must be small enough to be packaged in existing Marine Corps ADS stores, operate on low-level power, be capable of withstanding the shock and vibration of transit aboard tactical aircraft, specifically, the F&A-18 Hornet, be capable of withstanding the shock of ground implant, be accurate to within 5 degrees, and be capable of operating in a wide range of weather conditions. Additionally, this phase should address performance goals and provide evidence that the goals are technically feasible as well as identify all necessary efforts required in Phase II.

PHASE II: This phase entails the demonstration of the proposed technology to include: (1) Self orientation, (2) Integration into an existing Marine Corps sensor store, and (3) Delivery from Marine Corps high performance tactical aircraft to include ground implant.

PHASE III: Produce the hardware and any associated software/firmware developed in Phase II.

COMMERCIAL POTENTIAL: Application of this research will benefit numerous security systems manufacturing companies seeking to provide a wider range of target information. Any resultant technology has a wide range of application in drug/law enforcement as well as the defense industry. Additionally, such technology has application in commercial, hand-held navigation aids.

REFERENCES:
1. Air-delivered Sensor Report, Applied Research Labs (ARL), University of Texas at Austin
2. Advanced Air-delivered Sensor (AADS) Requirements Summary, Users Conference, Marine Corps Systems Command

KEY WORDS: Sensor; Air-delivered; ADS; self-orient; Marine: aircraft

NAVAL AIR SYSTEMS COMMAND

N98-019 TITLE: Stand Alone Environmental Corrosivity Measurement System

OBJECTIVE: To design and develop a low cost integrated data acquisition and sensor system which can measure the following parameters: Environmental corrosivity, temperature, relative humidity and rainfall conductivity.

DESCRIPTION: Corrosion costs the Navy in billions of dollars every year. Currently there is no means of quantifying environmental corrosivity as a function of the basing and operational environments. There is a need to develop a system which can obtain baseline environmental corrosivity measurements packaged such that the form factor is amenable to installation on Navy ships and bases. Part of this effort would be to design and develop a low cost integrated data acquisition and sensor system which can measure the following parameters: environmental corrosivity, temperature, relative humidity and rainfall conductivity. The system must be capable of unattended operation for at least 6 months and offer the option of remote data collection via modem or other wireless communication technologies. A methodology for automated data analysis will be required to support the interpretation of collected data.

PHASE I: Determine the feasibility of developing and designing a low cost integrated environmental corrosivity sensing and data storage system and fabricate a prototype.

PHASE II: Build several (at least ten) units of environmental corrosivity sensor systems as developed in Phase I. Install at least three systems: (I) at a ground station on a Naval Aviation Depot; (ii) on an aircraft carrier and (iii)on an operational aircraft. Collect and analyze data obtained during a minimum of one year test-exposure period.

PHASE III: Demonstrate the ability to manufacture low cost environmental corrosivity sensing systems (system hardware cost under $10,000/unit). Demonstrate the transition opportunity for fleet application in terms of reducing O&M costs through funding from NAVAIR (proposed 6.4 CBM Program) or other commercial interests.

COMMERCIAL POTENTIAL: This system offers dual-use potential of monitoring effects of environmental corrosion on commercial structures including: commercial aircraft, bridges, oil & gas platforms and pipelines, underground tanks, concrete rebars, hazardous waste storage facilities etc.

REFERENCES:
1. V.S. Agarwala, "Sensors for Corrosion Detection and Monitoring in Hidden Areas", proceedings of the Symposium on "Chemical Sensors II," Eds. M. Butler, A Ricco, and N. Yamazoe, The Electrochemical Society, Pennington, NJ, Vol 93-7, 698-708, 1993.
2. V.S. Agarwala and A. Fabiszewski, "Thin Film Microsensors for Integrity of Coatings, Composites, and Hidden Structures", NACE CORROSION/94 Conference, Baltimore, MD, Paper No. 342, NACE International, Houston, TX.
3. V.S. Agarwala, "Corrosion Monitoring of the Shipboard Environment", STP-965, American Society for Testing and Materials,

Philadelphia, pp 354-365, 1988.
4. V.S. Agarwala, "In-Situ Corrosivity Monitoring of Military Hardware Environments", NACE CORROSION/96 Conference, Baltimore, MD, Paper No. 632, NACE International, Houston, TX., P. 632/4.
5. V.S. Agarwala, "In-Situ Corrosivity Monitoring of Military Hardware Environments", NACE CORROSION/96 Conference, Baltimore, MD, Paper No. 632, NACE International, Houston, TX.

KEY WORDS: Corrosivity monitor unit; Sensor; data acquisition; "health" monitoring; low cost system; dual-use technology

N98-020 TITLE: Intelligent coatings for the detection and monitoring of corrosion on metallic surfaces

OBJECTIVE: To develop a reliable, real-time, field portable non-destructive (NDI) corrosion inspection system using intelligent coatings.

DESCRIPTION: The detection, monitoring and characterization of aircraft and ship structural integrity is essential for both military and civilian safety, affordability and reliability. Corrosion is one of the most critical element for cost and useful life today. Smart chemicals (intelligent coatings) have been developed and demonstrated to provide an early warning detection of corrosion by-products at the incipient stage. Present system (intelligent coatings) utilize UV radiation to excite fluorescent materials which either fluoresce upon combination with ions released during corrosion or fluoresce upon oxidation due to exposure to oxygen and moisture reaching them.

Thus far these techniques have been demonstrated in the laboratory; there is a need to develop optical instrumentation to record, store and analyze the data in the field. System concepts should include dye embedding techniques (encapsulation, polymer or sol-gel), imaging cameras (CCD, MCP), spectroscopy (lifetime, steady-state), and electronic integration (software and hardware i.e. DSPs, PCBs). Other spectroscopic techniques to monitor intelligent coatings will also be considered, such as absorption, magnetic resonance, SQUID, Raman, etc..

PHASE I: Explore and identify candidate intelligent coatings. Provide and demonstrate proof-of-concept of the proposed NDI technique.

PHASE II: Develop and fabricate a working NDI system using intelligent coatings. Demonstrate the technology on one fleet aircraft.

PHASE III: Identify funding source to transition this technology to NAVAIR and find a suitable industrial partner to develop a manufacturing process.

COMMERCIAL POTENTIAL: The developed NDI system would have broad military and commercial applications for aircraft, ships, storage tanks, missiles etc. which need early warning corrosion detection and monitoring. This NDI capability will result in lower life-cycle cost and reduction in maintenance man-hours of current military and civilian fleets.

REFERENCES:
1. V.S.Agarwala, "Chemical sensors for Integrity of Coatings", Proc. Tri-Service Corrosion Conference, U.S.Army Materials Technology Lab., Watertown, MA, pp.341-349, 1992.
2. R.E.Johnson and V.S.Agarwala, Materials performance 33,4(1994): pp.25-29.
3. R.E.Johnson and V.S.Agarwala, CORROSION/97 Conference, "Fluorescence Based Chemical Sensors for Corrosion Detection", Paper No.304, NACE International, Houston, TX, 1997.

KEY WORDS: Intelligent Coating; Smart Chemicals; Affordable; Microcapsules; Embeddable

N98-021 TITLE: Improved Leak Location System for Aircraft Internal/Integral Fuel Tanks/Cells

OBJECTIVE To develop a simple, low cost, highly reliable method for detecting and locating internal/integral aircraft fuel tank/cell leaks.

DESCRIPTION: Locating and eliminating/repairing fuel system leaks, particularly in internal/integral fuel tanks/cells, is an important part of the maintenance and acceptance test requirements of Navy aircraft. Unfortunately, current leak detection techniques are antiquated, and, therefore, are labor intensive/costly and lack the ability to quickly and accurately locate internal/integral fuel tank/cell leaks. Specifically, vacuum/pressure, soap bubbles, ammonia and dye, fuel dye, ultrasonics and warm gas emissions are current leak detection techniques used by Government Navy aircraft maintenance/repair activities and contractors. Each of these leak detection methods have shortcomings; namely: (1) difficulties in removing trace substances used during leak testing, (2)

difficulties in accurately locating fuel tank leaks and (3) labor and time consuming, and, therefore, costly. The benefits of this effort will include reduced aircraft down time and improved reliability/maintainability.

PHASE I: The primary activities during Phase I will be to identify a potential technology/system to improve on costly/manpower intensive techniques used to locate internal/integral fuel tank/cell leaks in repair, overhaul and production facilities. The system shall be light weight, reliable and utilize commercially available material. The system shall not decrease the reliability of the internal/integral fuel tank/cell. The contractor will be required to perform lab tests to show the potential for the technology and/or system to locate internal/integral fuel tank/cell leaks.

PHASE II: During Phase II the contractor shall demonstrate the technology on fuel cell test cubes or small scale tanks. The performance, effectiveness, sensitivity, weight, reliability and maintainability shall be evaluated and quantified.

PHASE III: During Phase III the contractor will propose their design concept for aircraft system implementation.

COMMERCIAL POTENTIAL: This system could be used in aircraft that use bladder, self sealing and integral type fuel cells/tanks.

REFERENCES:
1. MIL-T-27422
2. MIL-T-5578
3. MIL-T-6369
4. NAVAIR 01-1A-35

KEY WORDS: Fuel, Fuel Cells, Bladder, Leak Detection, Fuel Tanks

N98-022 TITLE: Innovative UAV VTOL Drive Technology

OBJECTIVE: To develop innovative propulsion system technology which would result in VTOL or near VTOL performance for UAVs

DESCRIPTION: The Navy is interested in developing innovative VTOL drive system technology for use on future UAVs. Currently VTOL UAV propulsion systems consist of rotary wing systems which are complex, or inefficient in forward flight, or they use tilting fuselages to generate high velocity and low mass airflow required for vertical takeoff and landing. The high velocity, low mass airflow designs are hard to control during wind gusts in hover. We are seeking innovative designs, that are not rotary wing or vectored thrust systems.

PHASE I: The offeror will provide a CFD and 6 degree of freedom models or subscale UAVs which demonstrate the proposed technology to meet the VTOL requirement.

PHASE II: Develop, test and operationally demonstrate a UAV utilizing the technology developed in the Phase I SBIR effort.

PHASE III: Produce the system developed during Phase II for transition into DoD UAV Programs.

COMMERCIAL POTENTIAL: This technology will have applications in commercial aviation for both passenger aircraft and in commercial applications of UAVs. Such as surveillance of damage in earthquake and forest fires.

KEY WORDS: VTOL, propulsion, UAV

N98-023 TITLE: Innovative Technology to Enhance Aircraft Software Configuration Control

OBJECTIVE: Develop an advanced innovative capability to evaluate the parametric effects of software changes during air vehicle, flight trainer, or related system acceptance testing.

DESCRIPTION: Testing modern Navy aircraft or Army advanced attack rotorcraft with integrated digital flight control systems can be very time consuming and expensive due to many factors, including the myriad of software changes made during the overall test cycle. Operational flight trainer acceptance also involves numerous software changes by the contractor trying to match performance requirements. The integrated test team needs an enhanced capability to help maintain configuration control during the test period. In the process of making software changes to improve performance, while trying to maintain configuration control, it is very important to determine precisely how a proposed software change will affect the individual subsystem being tested and the overall system being evaluated.

PHASE I: Determine the application of intelligent systems technology to software configuration control. Develop a plan

for an innovative program to support the integrated test team by precisely defining the effects that any parametric software change has on previous testing and on the overall air vehicle. Define the program applications and limitations to a specified multi-service rotorcraft and its associated flight trainers.

PHASE II: Develop the innovative program documented in Phase I. Demonstrate analytically how the program can be used to enhance software configuration control for specified rotorcraft. Demonstrate application on a specified simulator or digital flight control system test. Correct problems and incorporate recommended changes resulting form the initial tests. Deliver the final product, with appropriate documentation.

PHASE III: Extend the system application to support testing a different configuration rotorcraft.

COMMERCIAL POTENTIAL: The configuration control software would be used to support a variety of commercial software acceptance test programs for aircraft.

KEY WORDS: simulation, rotorcraft, software, configuration control, intelligent system, trainer, digital flight control

N98-024 TITLE: Ceramic To Metal Joining

OBJECTIVE: Bond a ceramic matrix composite such as SiC/SiC or SiC/C to a metallic structure. This joint must withstand the environment experienced in Naval aircraft.

DESCRIPTION: Ceramic technology is a break through for aerospace applications because they are lighter, temperature resistant, and more corrosion resistant than our current alloys. These new materials are being utilized to reach the Navy's goal of increasing the thrust to weight ratio of it's current gas turbine engines. These mature materials are fully developed and are ready for insertion into turbine powerplants. However, there is a dearth of information on the successful bonding of ceramics to current superalloys. To fully capitalize the benefits of ceramic materials, they must be successfully bonded to metal substrates that can withstand and operate in the gas turbine environment. To date, bonding or joining of the ceramics has had limited success.

It is the purpose of this work to bond a SiC/SiC or SiC/C ceramic matrix composites to a metallic structure such as a conventional super alloy. This bond must have integrity at 700 C. It has been demonstrated that the two family of CMC's mentioned above are mature for immediate insertion in our current aircraft. Currently they are mechanically fastened to the metal substrate. There is a need to replace conventional mechanical attachment with bonding.

PHASE I A bonding procedure will be developed so that a SiC/SiC or SiC/C ceramic matrix composite will be joined to an existing superalloy. The bond integrity will be examined at ambient as well as 700 C. Coefficient of Expansion measurements will be taken and documented. A preliminary stress analysis will be performed.

PHASE II Upon successful completion of Phase I, a family of ceramic to metal joints will be investigated and tested in the marine environment. This will include the latest superalloys and SiC/SiC or SiC/C exposed to both oxidation and hot corrosion environments. The successful bond will be manufactured and the stress fields will be fully modeled. The composition and bonding procedure will be presented and documented to the Navy for evaluation.

PHASE III The CMC bond procedure in Phase II will be transitioned to engine manufacturers. Navy Laboratories can use the information from this SBIR as a data base for similar applications. This work can be directly and immediately applied in the fleet. A successful bond will permit engine manufactures to incorporate CMC technology into their engines.

COMMERCIAL POTENTIAL: Industry can benefit from this product by utilizing ceramics in numerous conventional operations. These include Auxiliary Power Units, Land base gas turbines, and Aircraft gas turbines. The product will permit the wide use of ceramic materials that are exposed to elevated temperatures.

KEY WORDS: Bonding, Joining, Ceramic, Composite, Metal

N98-025 TITLE: Thermoset Resin Development for In Situ Fiber Placement

OBJECTIVE: To develop a toughened thermoset resin which is suitable for in situ cure during the fiber placement process.

DESCRIPTION: Fiber placement is an advanced composite process which has the potential to significantly reduce the cost of composite manufacturing through the efficient use of automation. In situ fiber placement of thermoplastics has been investigated, and has shown considerable cost savings by eliminating debulk cycles during lay-up and the autoclave cycle normally required for fiber placed or hand laid-up parts. However, thermoplastic resins are expensive and have not been qualified for most naval aircraft structural applications. Toughened thermoset resins are used for most naval aircraft composite components, but these resins were

developed for prepreg applications and have slow reaction rates which make them unsuitable for in situ fiber placement applications. A toughened thermoset resin developed with a higher reaction rate suitable for in situ fiber placement would potentially provide a cost effective alternative to standard fiber placement. This resin would need to have mechanical and thermal properties similar to currently qualified structural thermoset resins. The towpreg produced with the subject resin must be able to be used on existing production fiber placement equipment with only minor modifications.

PHASE I: The contractor is expected to formulate or modify a toughened thermoset resin with a reaction rate high enough to consolidate during the in situ fiber placement process at normal production speeds. The resin should be thermally and mechanically tested to establish Tg, rate of reaction, and fracture toughness. Initial prepreg (or towpreg) material should be evaluated by mechanical testing and microscopy examination.

PHASE II: Optimize the resin formulation if necessary. Demonstrate in situ fiber placement by fabricating and testing flat panels and one or more current naval aircraft components. Perform cost analysis to compare developed material/process to standard fiber placement process.

PHASE III: Choose a Navy fiber placed structure which could benefit from the developed material/technology. Assist prime contractor in the material and structural qualification/certification procedures with the new resin/fiber system. Use of existing tooling is encouraged.

COMMERCIAL POTENTIAL: Fiber placement of thermoset materials is presently being used on commercial as well as military aircraft. The development of an in situ resin system would improve the cost efficiency of fiber placement for aerospace applications by reducing labor, tooling, support equipment usage (autoclaves, ovens, vacuum tables), and schedule.

KEY WORDS: Fiber placement; in situ; resin; thermoset

N98-026 TITLE: Biofidelic Lumbar Spine for Human Response to Aircraft Ejection and Helicopter Crash

OBJECTIVE: To design and construct a lumbar spinal element that is compatible with the Hybrid III type manikins, which provides measures of tri-axial acceleration, provides measures of tri-axial loads and moments, and has biofidelity with respect to the human response to +Gz acceleration.

DESCRIPTION: The human operators of ejection seat aircraft and rotary wing air vehicles are subjected to severe vertical acceleration loads upon ejection and crash. Evaluation of the effects of such events currently utilize the state-of-the-art in automotive manikins. The dynamics of these events are so different from automotive crashes that these manikins, designed for the horizontal and lateral forces of a land-based crash, do not represent the spinal response to +z axis acceleration seen in human testing in vertical acceleration. As the current manikins do represent a good starting point for improvement, an improvement of the spinal element of the Hybrid III type manikin is desired that will provide measures of tri-axial acceleration, provide measures of tri-axial loads and moments, and exhibit biofidelity with respect to human response to +Gz acceleration.

PHASE I: Conduct a review of the current status of manikin spines and their responsiveness to vertical acceleration. Document the salient design characteristics of human response to vertical acceleration needed for a mechanical and electrical design. Design a prototype, complete with data package, that will exhibit these characteristics and meet the stated objectives.

PHASE II: Fabricate a prototype for each Hybrid III type based on the Phase I design. Perform bench level testing on prototypes in anticipation of government testing. Modify design based on test results available and produce a final design for the spinal element.

PHASE III: Once Phase II is completed, a follow-on Phase III effort is expected to manufacture the manikin spinal elements for testing in the ejection seat environment.

COMMERCIAL POTENTIAL: Such a modification would be used by all agencies and companies that perform biodynamic testing either for design of seating or qualification of such seats.

REFERENCES: Hybrid III: The First Human-Like Crash Test Dummy (SAE PT-44)

KEY WORDS: Ejection seat, Hybrid III, Biodynamic Testing

N98-027 TITLE: Phase Change Material (PCM) Enhanced Man-Mounted Liquid Active Microclimate Cooling System

OBJECTIVE: Reduce the size and power requirements of current man-mounted liquid active microclimate cooling systems through the use of phase change materials (PCM's). PCM's can be employed as microencapsulated PCM's circulating in an aqueous slurry,

in bulk form as a heat sink for the cooling fluid, or both.

DESCRIPTION: The current Chemical/Biological (CB) protective ensemble imposes a thermal burden on aircrew which not only limits mission time but poses a physiological danger to aircrew operating in even moderate environments. A small man-mounted cooling system employing active liquid based technology would enhance mission effectiveness and more importantly, would prevent a hazardous rise in core body temperature. The use of PCM could reduce the size and/or power requirement of the cooling unit while providing the same cooling effectiveness. The cooling unit would circulate the cooling fluid through narrow gauge tubing sewn to an undershirt worn against the skin. The unit should be capable of providing cooling for a minimum of 2 hours and should be powered by a rechargeable battery. The unit should produce a minimum of 150W of cooling with 200W desired and should provide that cooling rate in an environment of 100°F at 15% relative humidity. Since the cooling undergarment cannot be doffed during CB operations the cooling fluid should be water based and should not pose a hazard to the aircrewman in the event of a leak. The ideal unit would weigh less than 10 lb.

PHASE I: Provide a comparison of the use of a PCM enhanced fluid and/or a bulk PCM heat sink to water in the same cooling system, thus illustrating a clear performance improvement. PCM's of various chemical composition and slurries of varying PCM concentration should be explored. Provide design data which defines an optimal chemical composition, concentration (if slurry) and/or amount of PCM for a particular environment/application and fluid capacity. PHASE II: The Phase I data will be used to design/modify two systems in Phase II. Liquid active cooling systems will be developed which concentrate on a reduction in size and power requirement of the proposed units. The units will be tested and data provided to verify performance. The two units will be delivered to the US Navy for testing and evaluation.

PHASE III: Transition the units developed in Phase II into a Navy microclimate cooling program and production of units for commercial sales.

COMMERCIAL POTENTIAL: A man mounted active microclimate cooling system can be used in any industrial/commercial application requiring a reduction in heat stress.

KEY WORDS: Microclimate Cooling, CBR, Phase Change Material, Heat Stress

N98-028 TITLE: Development Of Fault Tolerance Analysis Tools For Flight Critical Avionics Systems

OBJECTIVE: The objective of this project is to develop advanced fault tolerance modeling and simulation techniques for flight critical avionics systems. This will increase the reliability, mission readiness, survivability, dependability and overall aircraft safety of flight while substantially decreasing the systems design, development, and integration time.

DESCRIPTION: Advanced flight critical avionics systems will place an increasing reliance on commercial off-the-shelf (COTS) processing and networking components. The fault tolerance or the ability of these systems to perform properly in spite of sporadic failures remains a major issue in their implementation in a military system. The problem is further complicated by the potential use of large numbers of smart components and subsystems as well as complex processing architectures. However, flight and mission avionics systems can be built using cost effective fault tolerance techniques to function normally even in the presence of failures. At present, modeling and simulation tools for systematically evaluating the fault tolerance, reliability, and dependability of these components and subsystems are either unavailable or not well suited for military applications. This program is aimed at the development of a systematic approach to the analysis of fault tolerance in advanced avionics systems. The tools developed under this program should support statistical dependability modeling and simulation based on Markov and Petri-net methods as well as functional fault-injection modeling and simulation. They should be sufficiently flexible to support virtual prototyping and analysis of both current and future avionics architectures.

PHASE I: Develop a set of metrics and use these metrics to evaluate capabilities of currently available fault tolerance modeling and simulation tools in terms of both quantitative and qualitative attributes. These attributers should be weighted in terms of each tools ability to meet the topic requirements and commercialization potential. Demonstrate theoretical basis for modifying available tools or developing new tools suitable for modeling and simulation of fault tolerance in military systems.

PHASE II: In association with a commercial developer of performance modeling tools, develop a complete set of modeling and simulations tools to support both statistical and functional fault-injection modeling and simulation.

PHASE III: Integrate the fault tolerance tools developed in Phase II onto the performance modeling system to market a commercial tool that will simultaneously model both performance and fault tolerance. Demonstrate the benefits of the integrated fault tolerant tool in a real world example such as on the JSF avionics, showing the cost saving associated with the design, development and integration.

COMMERCIAL POTENTIAL: The tools developed under this program will be directly applicable to commercial distributed and

parallel processing systems which require a high degree of dependability and availability.

KEY WORDS: Fault tolerance, avionics, networks, reliability, dependability

N98-029 TITLE: Automatic Derivation of Traditional Anthropometric Measurements From Whole Body Scan Data

OBJECTIVE: Automatically extract traditional anthropometric measurements from a three-dimensional point cloud data collected by a whole body scanner for design applications (clothing, workstations, equipment, systems engineering) and define algorithms to statistically summarize.

DESCRIPTION: Anthropometric data provide the fundamental basis for the design of protective clothing, military crewstations and cockpits, and individual equipment. Over 200 measurements have been defined as necessary or useful for these design applications. Using traditional tools, these measurements take about half a day to collect per person. Thus, traditional anthropometric surveys are rare and expensive (the US Navy's most recent survey was taken in 1964). New whole body scanning technology has been developed that provides body size and shape data in three-dimensional form, in seconds. However, most computer-aided-design (CAD) technologies expect two-dimensional inputs. A way to automatically define and extract two-dimensional anthropometric measurements from the three-dimensional point clouds generated by scanning systems needs to be developed. (Therefore, this method cannot involve traditional contact land marking).

PHASE I: 1) Describe in detail the technical approach to automatically derive two-dimensional data for both standing and sitting measurements, and 2) using US Navy provided scan data of a human subject, demonstrate the feasibility of the technical approach by accurately (data should not exceed error rates reported in TR-88/043) deriving 15 standing and 8 seated measurements specified by cognizant technical personnel.

PHASE II: Using the technical approach in Phase I, develop algorithms to 1) accurately derive 50-70 standing measurements; 2) accurately derive 40-50 sitting measurements on using US navy provided scan data; 3) develop software to statistically summarize data, and calculate multiple or bivariate regression equations, and correlation coefficients; and 4) provide software algorithms, software manuals, on-line tutorial, and other support.

PHASE III: Transition to the Navy's NRVANA program by integrating developed software with the source whole body scanner, CAD/CAM systems, systems engineering, and biomedical applications.

COMMERCIAL POTENTIAL: Automatic measurement of the human body using computerized systems will be indispensable for designers to apply accurate data to the design of consumer goods, such as automobile interiors, kitchen equipment, clothing, and industrial workstations and equipment.

REFERENCES:
1. Clauser, Tebbetts, Bradtmiller, McConville, and Gordon (1988) Measurer's Handbook: U.S. Army Anthropometric Survey, Natick Technical Report TR-88/043; NASA Anthropometric Source book 1024; DOD-HDBK-743

KEY WORDS: Anthropometry, body scanning, software, CAD, body measurement

N98-030 TITLE: Application Of Advanced COTS Architectures To Airborne Signal Processing and computing

OBJECTIVE: Develop a methodology for effectively using COTS based computers and processors in airborne applications.

DESCRIPTION: Historically, complex military system requirements have led to the procurement of unique hardware to provide the high throughput real-time processing and display necessary to satisfy complex mission objectives. In order to be cost effective, standards were developed for subsystem components including computers and signal processors to reduce the costly unique developments and corresponding Integrated Logistic Support (ILS) requirements associated with unique platform systems. Although the development of these computers and signal processors took up to ten years between development contract award and Initial Operational Capability (IOC), the standards met a need that was not yet satisfied by commercial-off-the-shelf (COTS) developments. The explosion in computer and signal processing technology has overtaken the need to specify and develop unique military system components and special military standards. A need exists to develop a methodology for effectively utilizing the COTS technology that advances on the order of three generations over a ten year period. This effort will assess the viability of using COTS based computers and processors in airborne systems as a cost effective alternative to custom designs.

PHASE I: Define the architectural capabilities and standards for a high performance, distributed system consisting of COTS components. This effort will define hardware elements, development and operational software environments and identify a real-time

application with which to demonstrate the architecture.

PHASE II: Demonstrate an advanced hardware architecture composed of a state-of-the-art processor configuration which makes maximum use of off-the-shelf components, open system architecture, relies on commercial industry standard communication media and physical connections, and drastically reduces the number of unique components. This effort should show that the existing airborne computing system components can be upgraded and/or changed without extensive application code development.

PHASE III: Full development and production for commercial and military airborne processors is envisioned.

COMMERCIAL POTENTIAL: Any commercial airborne computing system could benefit from this technology. Potential markets include airborne communications, on board system management, flight controls.

KEY WORDS: COTS, real time computing systems, signal processing, network analysis, legacy system upgrades

N98-031 TITLE: Marine Mammal Detection for Environmental Compliance

OBJECTIVE: Develop acoustic or non-acoustic sensors and signal processing techniques to detect, classify and localize marine mammals who could be present in designated danger zone during explosive operations.

DESCRIPTION: Explosive and live fire testing of weapons systems and vessels in the ocean environment are permitted when there is no significant impact on the environment, marine mammals or endangered species. Current testing strategies designate a danger zone around the explosive event based on predictions of lethality and harassment to species which could enter the danger zone. Explosive operations are suspended when a species enters the danger zone and are resumed when the species clears the zone. Reliable sensors and signal processing techniques dedicated to detection and localization of marine mammals are required with sufficient hardening to operate for multiple explosive events.

PHASE I: Conduct analysis of marine mammal characteristics and behaviors which permit efficient detection and localization over the range of 0.1 to 10 km. Based on the analysis, predict sensing techniques and signal processing schemes which permit near 100% probability of detection. Develop a sensor design concept and development plan.

PHASE II: Develop a sensor test model and signal processing hard/software which can be demonstrated in situ. Identify critical manufacturing technologies to permit the mass production.

PHASE III: Produce system models with hardening which can be demonstrated in live fire operations and successfully transition into production. Conduct operational tests and report conclusions and recommendations for production.

COMMERCIAL POTENTIAL: This technology supports marine mineral exploration in the commercial sector and allows regulating agencies to both protect and survey marine mammal population densities.

REFERENCES: OPNAVINST 5090.1B

KEY WORDS: Explosive testing, Marine Mammals, detection, protection

N98-032 TITLE: Frequency Selective filter/Switch

OBJECTIVE: Develop an innovative means of selectively routing increased jamming power to one direction from an aircraft while not interfering with fore and aft jamming of emitters at other frequencies.

DESCRIPTION: Historically, pulsed and continuous wave (CW) outputs of an airborne jammer are combined in a microwave hybrid and then split for simultaneous routing to forward and aft aircraft antennas. Against certain radars it may be more effective if a selected frequency portion of the CW jamming is redirected in a particular lower hemisphere direction. This may involve reflecting the signal off the ground or off a chaff cloud or just focusing the energy in a narrower region to get more effective radiated power. In these cases the antenna gain may have to be increased and/or the microwave transmission line/component losses decreased. It may also be necessary to redirect portions of the CW spectrum to the alternate path and back while jamming power is applied, i.e., hot (high power) switching. In addition, the normally transmitted jamming signal may have to be attenuated so it doesn't reach the radar/missile receiver at a level higher than the redirected path. Since jammers must handle multiple radars, the primary jamming path should be maintained for normal pulse and CW jamming.

PHASE I: This study should determine which emitters could be more effectively jammed by using an alternate antenna on a tactical Navy aircraft. This study should determine the feasibility and develop an optimum approach for allowing a deployed jammer with a CW output to perform CW jamming via alternate antennas for selected frequencies while still using existing antennas

for CW and pulsed jamming for the majority of the frequencies.

PHASE II: Fabricate a prototype implementation of the system. Testing should include effectiveness of jammer controlled antenna switching mechanism against modern day radar controlled missile systems.

PHASE III: Fabricate and deliver additional systems for test and integration into existing US Navy tactical aircraft.

COMMERCIAL POTENTIAL: The application is applicable to co-site signal interference reduction and upgrades to Foreign Military Sales (FMS) aircraft/jammer installations.

KEY WORDS: Continuous Wave (CW), Electronic Countermeasures (ECM)

N98-033 TITLE: Magnetic Anomaly Detection (MAD) Geomagnetic Reference Sensor

OBJECTIVE: Develop an off-board sensor of geomagnetic noise for use with Advanced Capability (ADCAP) MAD detection and recording systems.

DESCRIPTION: As platform noise is reduced in ADCAP MAD detection systems, background noise/ clutter sources begin to have a dominating influence upon detection performance. The geomagnetic noise in an area is correlated over ranges of at least several kilometers. An off-board sensor placed within the correlation range, but far from the expected target anomaly could be used to measure the geomagnetic noise. This could, in turn, provide potentially useful information to allow processing techniques such as common mode rejection to reduce the primary sensor's background noise and; thus, improve system performance. Recommended developmental phases are outlined as follows:

PHASE I: Quantify the performance gains possible from off-board measurement of geomagnetic noise in operational contexts. Develop system concepts and evaluate performance, cost and compatibility with potential airborne Antisubmarine Warfare (ASW) MAD systems and procedures. Explore all additional uses/value-added of the sensor option. Specify hardware/software requirements and sources for a prototype system. Propose and conduct appropriate risk reduction experiments.

PHASE II: Build and test prototype off-board geomagnetic sensor and signal processing software and hardware for noise rejection in the context of ADCAP MAD systems. The prototype need not be fully compatible with all ASW platform systems, but a clear and short development trail must be established to show how full compatibility could be achieved.

PHASE III: Develop and deliver off-board sensing system for use by ASW aircraft equipped with ADCAP MAD system technology.

COMMERCIAL POTENTIAL: Advanced magnetic sensors are presently under consideration for potential employment in various commercial applications. These include: Geological exploration, detection and characterization of underground bunker facilities and the potential to assist in on-site inspections to determine compliance with nuclear weapons test ban treaties. Noise reductions attained in the case of submarine magnetic anomaly detection could also be of significant value in these as well as other commercial developmental applications.

KEY WORDS: MAD, Magnetics

N98-034 TITLE: Multisensor Image Positioning System for Tactical Level Targeting

OBJECTIVE: To develop techniques for establishing the precise geometric relationship between tactically acquired imagery and other image sources which are tied to geodetic coordinates.

DESCRIPTION: Tactical level targeting requires the ability to coordinate tactically sensed data with GPS targeting coordinates. The intent of this topic is to solicit development of algorithms to perform automated positioning of different data types with respect to a single coordinate system. In particular imagery derived from electro-optical (EO), infrared (IR), and synthetic aperture radar (SAR) sensors should be considered. Particular attention should be paid to EO to SAR image registration. In addition, digital elevation maps (DEM) resulting from IFSAR processing and/or DTED should be accommodated and utilized when available. Performance bounds for performing the image-to-image registration with and without knowledge of the local terrain elevations should be investigated. The system should be flexible enough to position as few as two of the above mentioned data types relative to each other or as many as all of the data types mentioned. It is anticipated that representative data will be made available to verify the capabilities of the system developed under this effort.

PHASE I: Describe in detail the algorithms identified and/or developed to meet the requirements set out above for all possible combinations of data types. Estimate anticipated registration accuracies and bounds within which the proposed system can

be expected to operate. Demonstrate the ability to ortho-rectify the imagery if necessary. Demonstrate performance of the techniques on limited data sets in an experimental setting. Address issues related to speed of processing and describe the benefits of this innovative approach over other proposed approaches. Research quality source code for performing these tasks should be delivered at the completion of Phase I.

PHASE II: Extend the approaches developed under the Phase I to accommodate a larger variety of data types, in particular positioning of forward looking imagery relative to down looking imagery (and vice versa) should be addressed. The focus of this work will be to address the handling of data types containing a significant amount of perspective distortion as in imagery collected by a low altitude tactical UAV over very mountainous regions. Develop a prototype system for performing these tasks, expected deliverables include a detailed report of algorithms employed as well as standalone source code.

PHASE III: Expand the Phase II prototype into an operational system that can be easily integrated with deployed systems.

COMMERCIAL POTENTIAL: Techniques developed to fulfill the requirements of this topic will provide a flexible solution to many problems in surveillance, targeting, and multisensor data exploitation. The developed system will provide capabilities to assemble, update, and maintain geographical information databases using imagery collated from different sensor types and platforms. Given such a system, new imagery can be quickly integrated into the database so that site monitoring change detection tasks may be performed. The applications of such a system include search and rescue, forest fire monitoring, map generation, and counter-drug surveillance.

REFERENCES:

1. H. Li, B.S. Manjunath, S.K. Mitra, "A Contour-Based Approach to Multisensor Image Registration", IEEE Transactions on Image Processing, Vol. 4, No. 3, March 1995, pp. 320-334.

2. R. Chellapa, Q. Zheng, P. Burlina, C. Shekhar, K.B. Eom, "On the Positioning of Multisensor Imagery for Exploitation and Target Recognition", Proceedings of the IEEE, Vol. 5, Issue 1, January 1997, pp. 120-138.

KEY WORDS: Multisensor data, image positioning, image registration, targeting, tactical, digital elevation models.

N98-035 TITLE: Signal Processing and System Concepts to Exploit Passive Signals in Airborne Active ASW Missions

OBJECTIVE: Use advanced processing and system concepts to enhance performance of future airborne ASW systems operating in high clutter environments.

DESCRIPTION: Although future airborne ASW systems will rely heavily on active acoustic methods acquire and locate submerged targets, exploitation of passive target signals can provide value-added to the detection, classification, and localization phases of an active search problem. Operator workload during ASW search will be dominated by use of the active tactics and data analysis, and significant passive data may be lost if capability is not incorporated into the system design. This SBIR will address how passive signal exploitation can be used to enhance active acoustic search.

PHASE I: Define innovative system concepts, signal processing, and display techniques to exploit passive signals in an Airborne active search mission. The concepts must demonstrate value-added to the active search, as well as feasibility in implementation. The Phase I effort will identify the signal types to be exploited, and how the techniques will work in a system context.

PHASE II: Develop a working prototype of the techniques defied under the Phase I SBIR effort. The prototype system will be used to demonstrate the system concepts using real data furnished by the Government, and must be consistent with transition of the concepts to fleet systems.

PHASE III: Implement the systems concepts, and signal processing and display techniques in a fleet ASW platform configuration (P-3, S-3).

COMMERCIAL POTENTIAL: The systems concepts and processing techniques developed under this task can be applied to commercial sonar systems. Combined Active and Passive processing would be beneficial for marine mammal tracking and could be applied to commercial security and surveillance systems.

KEY WORDS: Anti-Submarine Warfare, Signal Processing, Passive Processing, Display Techniques

N98-036 TITLE: Light-Weight Airborne Repeater for Tactical Radio Networks

OBJECTIVE: To design, demonstrate, and develop a lightweight, low power combat net radio (CNR) repeater package which can be deployed in UAV's.

DESCRIPTION: The Navy is often required to support and implement tactical radio communications links for beyond LOS or extended range applications in difficult terrain. While alternate communications media (SATCOM, HF, etc.) are available, the use of these media can lead to excessive congestion and requires combat elements to transport excessive amounts of equipment and batteries. Successful development of an airborne relay capability will allow combat and support elements to use existing local area CNR assets to support extended range communications.

Three CNR airborne relay configurations are of interest to the Navy, which will select a single configuration for further development depending upon the results of the Phase I trade studies and analyses. The first configuration shall be similar in nature to a conventional re-transmission arrangement, with separate transceivers and antennas connected so as to effect a re-broadcast function. The second configuration shall be similar to the first but shall employ a single antenna. The third configuration shall also utilize a single antenna, but shall be implemented as a store-and-forward node for data traffic, as opposed to simultaneous or pseudo-simultaneous active transmission and reception as in configurations 1 and 2.

Issues to be addressed by the successful offeror include; Size, weight, and power of the candidate architectures; Compatibility with Naval UAV assets; Suitability for simultaneous voice and data access; Tradeoffs related to multiple vs. single antenna architectures; Implementation of the SIP SINCGARS waveform; INFOSEC implementation; Cosite interference and RF performance; Coding performance of SIP EDM modes.

PHASE I: Develop a top-level approach for each of the candidate configurations, addressing the issues listed above. Each configuration shall support all SIP SINCGARS modes in a package consistent with the candidate configuration. Analyze each configuration to determine the optimum airborne relay configuration with respect to size, weight, power, cost and performance.

PHASE II: Develop a prototype of the optimum airborne relay configuration. Integrate this configuration within a suitable UAV platform and perform simulated operational testing.

PHASE III: Transition the prototype airborne relay configuration into a Navy production program.

COMMERCIAL POTENTIAL: An airborne relay capability can be adapted to a variety of platforms and utilized by law-enforcement agencies and other non-DOD organizations to support wide-area voice and data communications in remote areas or under emergency conditions when other communications media are unavailable. The technology, through RF and digital signal processing and coding, can be used to enhance the performance of spread spectrum wireless RF communications networks which are degraded by extreme near/far ratios.

KEY WORDS: digital radios, spread spectrum, SINCGARS, airborne relay

N98-037 TITLE: Optical Phased Array Sensor and Processor Development

OBJECTIVE: Develop sensor and image processor technology which provides a hemispherical area of regard and zoom capability using solid state technology and no mechanical articulation.

DESCRIPTION: Unmanned Aerial Vehicle (UAV) Electro-Optical sensors currently use the Edison paradigm (movement of the optical path elements) to accomplish panning, tilting and zooming within the sensor's area of regard. While the actual focal plane arrays are becoming increasingly denser and smaller, the articulation mechanisms have mechanical limitations which are expensive to overcome using traditional stabilization methods. Traditional methods also carry weight and power penalties. A solid state, non-mechanical, digital sensor and processor which allows high resolution pan, tilt and zoom would be light weight (less than 5 pounds target) and accomplish all the functions of an Edison based system via Digital Signal Processing. The Optical Phased Array and Image Processor (OPAP) would be employed using daylight and solid state uncooled FLIR technology providing day/night capability. Sensor capability would exceed MOKED 200/400 (target) while allowing a 90% reduction weight and volume, allowing more room for other payload integration on otherwise overtaxed airframes.

PHASE I: Provide a feasibility study which develops a method to increase the effective density (zoom level versus granularity) of the digital sensor and the accompanying processor software which allows digital pan, tilt, zoom and stabilization.

PHASE II: Develop, test and operationally demonstrate the OPAP methods formulated under the Phase I SBIR effort. Provide field test units for integration into target UAV.

PHASE III: Produce manufactured units for installation on designated UAV's.

COMMERCIAL POTENTIAL: Lower acquisition and maintenance costs would make OPAP technology attractive for commercial

sensor users such as security companies. The lower weight would allow development of light weight commercial UAV systems. The low cost and light weight would make this technology a simple add on sensor for law enforcement helicopters.

REFERENCES: EIA RS-170, NTSC, HDTV

KEY WORDS: digital sensors, Focal Plane Arrays, Micro-bolometer, FLIR

N98-038 TITLE: Low-latency, Protocol Independent, Network Interfaces for Advanced Avionics Systems

OBJECTIVE: Develop high-performance network interfaces consisting of protocol independent (either message passing or shared memory) software, and very low-latency hardware, which enhance portability, and interoperability between networks and computer architectures in advanced avionics computing and communications systems.

DESCRIPTION: Next generation avionics systems will require dramatic increases in processing to support capabilities such as digital receivers, battlefield wide information networks, and multi-platform, multi-sensor fusion. These systems will exploit parallel and distributed computing and will require concomitant orders of magnitude increases in network capacity and orders of magnitude decreases in latency. Commercial-off-the-shelf (COTS) technology must be used to control costs. One of the major impediments to the development of COTS-based high-performance computing and communications is the processor-interconnect interface. Current components emphasize heavyweight software interfaces and I/O-bus interfaces which curtail sustainable throughput of gigabit/second interconnects to as little as 100-Mbps and inflate message-passing latency into the milli-second range. This program is targeted at the development of a lightweight software interface for both message passing and shared memory, and a very low latency close-to-the-processor hardware interface. The software interface should provide lightweight communications, low-latency multithreading, application-to-network independence, object request brokering, interoperability, and portability across message-passing and shared-memory networks for distributed and parallel applications. The Common Object Request Broker Architecture (CORBA) development should be tracked and compatibility maintained. The hardware interface should provide throughput approaching either the processor-memory bandwidth or the sustainable interconnect throughput (whichever is less), with latencies of less than one microsecond, at a unit cost of less than $2000 in quantity. In addition, a ruggedized version of the hardware interface should be capable of operating over the military temperature range.

PHASE I: Demonstrate feasibility of the interconnect interface by modeling and simulation of software and hardware throughput, latency, cost, functionality, size, power, and weight. Evaluate and select the COTS-based processor architecture, software components, and interconnect, to be supported.

PHASE II: Develop and demonstrate software and hardware interface prototypes. Evaluate prototypes for throughput, latency, cost, functionality, size, power, and weight. The results of this evaluation should be used to verify Phase I modeling and simulation results and to estimate the unit cost of military and commercial interface systems.

PHASE III: In conjunction with a commercial interconnect vendor, develop a low-cost integrated module and software suite suitable for both commercial and military applications.

COMMERCIAL POTENTIAL: The high latency and low throughput of software and hardware interfaces for high-performance interconnects currently available represents a major limitation to their introduction into commercial distributed and parallel clusters of workstations. The development of low-latency, high-throughput interface components would represent a breakthrough in the field of high-performance computing and communications. It would revolutionize the effectiveness of the many hundreds of thousands of COTS-based clusters of workstations in the field to better exploit advances in distributed and parallel computing.

REFERENCES:
1. IEEE 1394.2 Serial Express (Draft);
2. IEEE 1596-1992 Scaleable Coherent Interface;
3. Myrinet: A Gigabit Per Second LAN;
4. ANSI X3.288-1996 Information Technology - Fibre Channel - Generic Services;
5. Joint Advanced Strike Technology Program, "Avionics Architecture Definition, Version 1.0, Aug 9, 1994";
6. OMG CORBA 2.0/IIOP Specification.

KEY WORDS: Avionics data networks, computer architecture, high-performance computing, parallel computing, high-performance communications

N98-039 TITLE: Pulse Detection Electronic Hardware for Multi-discriminant Laser Radar

OBJECTIVE: Develop pulse detection algorithm and electronic hardware for laser radar for improved range accuracy and for full exploitation of the information content of the returned pulse.

DESCRIPTION: For a direct-detection time-of-flight laser radar seeker, high speed and compact pulse detection electronic hardware is needed to determine the range to target. Improved pulse detection algorithm could enhance the noise performance of the seeker, and could provide more precise range measurement. The returned pulse potentially contain useful information that can be correlated with the material or type of reflector and other clues useful for target recognition. This electronic hardware must be able to process millions of pulses a second. As a minimum, it must provide as output the range and "intensity" of the pulse.

PHASE I: Develop pulse detection algorithm and software. Demonstrate performance and capability using synthetic returned pulses. Conduct a study to determine the trade between speed, complexity of algorithm, and features. Perform preliminary design of hardware. Identify and establish clear path to hardware mapping. Explore teaming arrangement for interface to a real laser radar. Deliver the algorithm, software and documentation to the government.

PHASE II: Concentrate on final design and fabrication of this pulse detection electronic hardware in ASIC or the like. Testing the hardware in an experimental environment in the laboratory. Access the performance of the pulse detection hardware including speed, range accuracy, noise performance, intensity channel fidelity, and other features. Iterate the algorithm/software enhancement, fabrication and testing process. Establish teaming arrangement for interface the fabricated hardware to a real laser radar. Deliver a current version of the algorithm and software to the government.

PHASE III: Fabricate a version of the pulse detection electronic hardware that conforms to the targeted laser radar in term of form factor, power, temperature, speed requirements etc. Assist in the integration of the pulse detection hardware. Field demonstrate the hardware by collecting laser radar images. Analysis the performance of the pulse detection hardware.

COMMERCIAL POTENTIAL: This could also improve the performance of laser radar used in robotics and those used in building highly accurate 3D CAD models used in manufacturing.

KEY WORDS: Pulse Detection, laser radar, ASIC, seeker, range, intensity.

N98-040 TITLE: Weapon System Operator Tactical Operation Aids

OBJECTIVE: Investigate the utility of using weapon system operator initiated voice commands for tactical software function initiations, in conjunction with Tactical Decision Aids (TDA's) and cueing of operator for action on high interest or critical situations.

DESCRIPTION: Develop the combined use of voice commands, tactical decision aids, and cueing as a form of TDA to increase weapon system operator performance in high load scenarios. The combined enhancements to a weapon system have the potential to significantly reduce operator workload while increasing the WSO's ability to react and proact to potentially hazardous situations.

PHASE I: Provide a feasibility study to determine the best mix of cueing and voice recognition functions to be implemented in the tactical platform. Interact with tactical operators and software development teams to:

1. Determine the basic tactical functions to be employed in the voice recognition system.
2. Determine the best cueing methods and under what circumstances they should be initiated.
3. Determine the TDA's that should be developed and how they should be initiated and modified if required real time.
4. And enhance the operational effectiveness of operators and pilots.

PHASE II: Develop, test, and operationally demonstrate the voice recognition, cueing, and Tactical Decision Aids on the operators situational awareness in a lab environment.

PHASE III: Produce, test, and operationally demonstrate the voice recognition, cueing, and Tactical Decision Aids in a tactical display and its effects on the operator or pilots situational awareness.

COMMERCIAL POTENTIAL: Numerous applications in air traffic control, industrial production monitoring, power plant control and distribution.

KEY WORDS: Voice Recognition, Cueing, Decision Aids

N98-041 TITLE: Low Cost, Light Weight Optics For Improved Multi-Function EO Sensor Performance

OBJECTIVE: Reduce the cost and weight of reflective optics and structures for EO multi-function sensors through use of BeA1 material, replication and bolt together alignment.

DESCRIPTION: Electro-optical sensors for air, helicopter, ship and submarine applications increasingly require multi-wavelength performance to provide functions such as color TV, NIR TV, laser ranging and designation, and MWIR plus LWIR imaging and tracking. To provide these functions through a common aperture, sensors require wide FOV all reflective, off axis fore optics which are sensitive to alignment and costly relative to lenses in a barrel. Weight is an additional cost and complexity driver, particularly for tail mounted and mast mounted systems where weight limitations drive designs to the extremes of weight reduction. This effort will reduce the weight of EO sensors by enabling use of BeA1 for both the optical structures and mirrors; BeA1 has 3 times the stiffness, 0.78 the density, half the CTE and 4 times the damping of Aluminum which is currently used for athermal, precision machined, bolt together reflective optics. The higher stiffness and lower density imply substantial weight savings and the lower CTE will ease sensitivity of the optics performance to thermal effects. The effort will further reduce the cost by taking advantage of advances in replication technology that are being made by ARPA on the precision optics manufacturing program. This SBIR will take both BeA1 and reflective optics replication technology through to practical application in Navy optical systems.

PHASE I: Provide a study to take BeA1 and replication technology into the design of off-axis three mirror WFOV telescopes needed for the fore optics in future multi-function EO-sensors.

PHASE II: Perform the design, fabrication and test of a concept developed in phase 1. The BeA1 and replicated optical telescope will be tested over thermal and other environments typical of air and helicopter borne sensors.

PHASE III: Transition the reflective optics system into a Navy program for performance evaluation in an operational environment.

COMMERCIAL POTENTIAL: The technology can be applied to many applications ranging from law enforcement and multi-spectral earth resources monitoring to a new class of amateur telescopes and accessories for the professional photographer.

KEY WORDS: Reflective optics, replication, EO sensors, Structures.

N98-042 TITLE: Environmentally Adaptable Detector/Classifier

OBJECTIVE: Design in situ environmentally adaptive algorithms to automate detection and classification processes for a Coherent Active Sonar Search System.

DESCRIPTION: The Navy is currently developing Active Sonar detection and classification automation for coherent waveforms to reduce operator workload and to aid in their decision making. This is critical to the success of the Search mission; because multi-beam/ multi-static sensor data and limited analysis time severely restricts the operator's ability to manually analyze and classify target/clutter returns. The goal of this effort is to develop environmentally robust algorithms that significantly increase detection and the ability to discriminate target returns from clutter. A number of important echo properties used for detection and classification are a function of the environment. These properties can be extracted real time from multi-static direct blast returns during the initial Search activity. Knowledge of the medium's effect on the transmitted signal can then be incorporated into the algorithms to optimize performance. The algorithms must be based on direct blast properties that correlate well with corresponding target returns. The algorithms must be integrated into current coherent baseline processing architecture and written in MATLAB.

PHASE I: Compile and evaluate sea test statistics of relevant environmentally dependent properties to determine their detection and classification merit. Statistical target/clutter probability curves need to support these conclusions. Quantify correlation between the direct blast and target properties and develop the techniques to utilize this information in the automated algorithm design. Select, develop, and test prototype detection and classification algorithms. This task will require using existing sea test data and leveraging off of on-going Navy sea tests to obtain the necessary statistical data base. Planning and supporting sea tests are required. Deliver a summary report with recommendations for phase II.

PHASE II: Develop and test prototype detection and classification algorithms and integrate into the coherent processing architecture. Generate appropriate probability curves to assess performance. Continue to participate in Navy sea tests to gather more statistics over a variety of environments. From this data refine and test algorithms. Deliver a summary report with recommendations for Phase III.

PHASE III: Transition of prototype design to fleet. Conduct three sea tests at different environments to verify algorithm performance stated in phase II. Assist Navy in implementing algorithms into P-3 avionics. Support the Navy in evaluating their performance in the Tech Eval phase.

COMMERCIAL POTENTIAL: Use by the acoustic commercial community to aid in detection, classification, and tracking of marine mammals for purposes of study and protection.

KEYWORDS: Detection, Classification, Active Sonar Search.

N98-043 TITLE: Advanced SAR Techniques Including UWB/UHF for Mine and Unexploded Ordnance Detection/Classification

OBJECTIVE: The objective of this topic is to explore and transition advanced SAR techniques, particularly in the low frequency UWB/UHF region, through new and novel analysis, processing, and system techniques including (but not limited to) those applied to foliage penetration (FOPEN), ground penetration (GPEN), mine detection, and unexploded ordnance (UXO) detection/classification.

DESCRIPTION: Synthetic Aperture Radar (SAR) imaging is being used increasingly in a broad spectrum of all-weather military and nonmilitary applications. Bands of interest include X band but also include greater interest of late in the UltraWideBand (UWB) UHF (and lower) frequency range. Areas of importance to the Navy littoral surveillance mission span from wide area surveillance and target cueing to target ID and accurate geolocation. Also of increasing interest are terrain characterization and mapping, particularly in rugged forested regions for military as well as commercial and environmental application. As the spectrum of potential geographic regions of interest grows, more robust analysis, processing, modeling, and implementation techniques are required in order to accurately characterize targets and clutter in the respective terrain environments. Novel, robust analysis approaches to optimal focusing, statistical terrain and target characterization, polarimetric terrain and target characterization, ground cover species identification, RFI/interference rejection (particularly for low frequency foliage/ground penetration systems), image formation/registration, interferometric terrain mapping, FOPEN 3D target characterization, and FOPEN GMTI/GMTIm will be of greatest interest and impact for future systems. Mine and UXO detection/classification are included as representing among the most difficult challenges during, and particularly following, regional conflicts. All efforts will be coordinated with other Services and DOD agencies involved in UXO applications.

PHASE I: Explore new and robust modeling and analysis techniques in order to demonstrate the greatest feasibility of improving the SAR image formation process and image product with the overall goal of extracting optimal information from terrain scenes over various littoral region types. As a minimum, algorithms and techniques should be provided with stand-alone prototype codes, where appropriate, for demonstration of feasibility and evaluation.

PHASE II: Using the technique(s) developed in Phase I, extend and improve the design(s) for robust performance over a variety of terrain and target types. Quantitative performance measures will be developed and applied for comparison to current/conventional techniques over diverse sets of government supplied SAR data. Where appropriate, hardware and/or software products will be expected.

PHASE III: Transition algorithms and techniques into ongoing projects, both military (ONR, DARPA, NAVAIR, etc.) and nonmilitary (e.g., environmental and/or commercial).

COMMERCIAL POTENTIAL: The utility of low frequency SAR is only now emerging as an important remote sensing tool for environmental as well as disaster response applications. The ability to penetrate foliage, and to some extent the ground, could have profound impact in some areas such as forest wetlands management, geological/resource exploration, and law enforcement (in terms of counter drug surveillance in remote regions). Robust imaging techniques will be required in order to extract optimal information from this data.

REFERENCES: "Proceedings of SPIE AeroSense Conference, Algorithms for Synthetic Aperture Radar Imagery II," Spie Proceedings Vol. 2487, 19-21 April 1995, Orlando, Fla.

KEY WORDS: SAR; image formation; focusing; motion compensation; statistical characterization; unexploded ordnance (UXO), speckle, polarimetry, GMTI, interferometry, IFSAR, mine detection

N98-044 TITLE: Innovative Signal Detection for Impulsive-Source active sonar systems operating in shallow water

OBJECTIVE: To develop innovative signal detection algorithms for air-deployed active sonar systems that use impulsive sources, sonobuoy receivers and operate in highly cluttered littoral environments.

DESCRIPTION: To successfully operate in the coastal waters around the world, the Navy must be able to reliably detect the presence

of enemy diesel-electric submarines operating in these areas. While impulsive-source active sonar systems can provide the acoustic energy necessary to detect submarine echoes, reflections of this energy off the complicated sea bottoms in these shallow waters can produce numerous "false" or clutter echoes. For an active sonar system to be effective, it must be capable of distinguishing these clutter echoes from actual submarine echoes. Current energy detection algorithms cannot maintain a low rate of clutter detection while providing a high probability of target detection. Hence, there is a need to develop new detection algorithms.

PHASE I: The initial part of Phase I will be to develop several candidate detector structures and to evaluate their performance using simulated data. Next, the candidate detectors will be applied to a limited amount of real data and their performance compared to that of the "standard" energy detectors. These real data results will be used to assess the potential of the candidate algorithms to provide real-world performance improvements.

PHASE II: The candidate detection algorithms will be applied, in a lab setting, to all available at-sea data. The algorithms must provide good performance in all environments. As was done in Phase I, all performance results will be compared to those provided by standard energy detectors. The extensive real data analysis performed in Phase II will effectively quantify the improvement of the new algorithms over the conventional detectors. If this improvement is deemed sufficient, one of the candidate algorithms will be identified for transition to Phase III.

PHASE III: The detection algorithm identified in Phase II will be implemented in COTS hardware, installed on an ASW aircraft, and flown out to sea for real world testing. Tests will be conducted in a variety of environments to insure that the algorithms are providing the environmentally stable performance indicated in a successful Phase II effort.

COMMERCIAL POTENTIAL: Detection algorithms developed in this work are potentially useful in a variety of medical applications, including tumor detection and tissue pathology characterization with ultrasonic pulses. They may also prove useful in locating impulsive sound sources, like gunfire, that occur in the complicated, clutter-filled propagation conditions of a city.

KEY WORDS: active sonar, shallow water, impulsive source, signal detection, clutter rejection, signal classification.

N98-045 TITLE: Low Cost Adaptive Optics for Commercial and Military Systems

OBJECTIVE: Develop an adaptive optic system to extend capabilities of commercial and military imaging sensors in inclement weather.

DESCRIPTION: Imaging systems utilize reflected visible or infrared radiation to form images of the scene. The limiting factor in imaging is frequently the air turbulence caused by winds, high temperatures, and other weather conditions. This is especially true for long distance imaging in which air turbulence often degrades significantly the resolution capability of the sensor. Adaptive optics can correct the effects of air turbulence by sensing the incident wave front and reshaping the mirror to correct for the turbulence induced distortions. Current adaptive optical systems, however, are limited in their practical use due to high costs and bulky applications. A novel lightweight mirror system which distorts the mirror faceplate as needed, but requires little volume and which can be manufactured inexpensively would extend adaptive optic capabilities to dozens of commercial and military applications. Two or three competing concepts exist for accomplishing the inexpensive, small volume optical corrections. Two of them would be competitively selected in Phase I of this SBIR; the most promising would succeed to Phase II.

PHASE I: Conduct feasibility analysis to determine those conditions where adaptive optics may provide useful enhancement. Design an adaptive optic system to extend capabilities of commercial and military imaging sensors in inclement weather. The system will be lightweight, inexpensive to manufacture, and small in size. The system will be developed to operate in military seekers, FLIR (Forward Looking Infrared Radar) and commercial imaging systems.

PHASE II: Develop, Test and demonstrate under realistic conditions the most promising adaptive optic techniques proposed in Phase I. Seek commercial and military sponsors for Phase III.

PHASE III: Build prototype adaptive optical systems by the techniques demonstrated in Phase II. Apply to military seeker and FLIR systems as well as to commercial imaging systems.

COMMERCIAL POTENTIAL: New method will be used in telescopes, space-to-earth optical systems such as SELENE, security systems, airbourne surveillance, spotting systems and other commercial optical systems.

REFERENCES: References will be provided to DTIC for distribution to requesting bidders.

KEY WORDS: Sensor, adaptive optics, infrared systems, long-range viewing, atmospheric compensation and enhanced resolution

N98-046 TITLE: Embarked Aircraft Tracking System (EATS)

OBJECTIVE: Develop a system to automatically and continually locate, identify and track all aircraft embarked on an aircraft carrier from the time it is recovered until the time it is launched. Information from this system will serve as inputs to current, planned and future aviation information systems deployed on aircraft carriers. This system will contribute to an increase in aircraft sortie generation rate while reducing manpower.

DESCRIPTION: The aircraft carrier is a mobile sea based platform that provides power projection through tactical aviation. A measure of aircraft carrier performance is aircraft sortie generation rate. Sortie generation is driven by several factors, one of which is aircraft turnaround time. The current aircraft turnaround process is initiated upon recovery and includes: assessment of its condition, maintenance if necessary, refueling, ordnance loading, and one or two respots before taxiing to a launch position from which it departs the ship. Aircraft condition and location are critical pieces of information for handling, servicing, and maintenance personnel. Currently, aircraft arrival, identification, status, and tracking are all done manually by many shipboard personnel transferring data via word of mouth. The data is then recorded/displayed by various means which include large grease boards and a manual spotting board using aircraft templates on two-dimensional scale models of the flight and hangar decks. This current method is manpower intensive, has a slow data transfer rate, is prone to the passage of erroneous data, results in additional aircraft respots, is inefficient, and results in increased aircraft turnaround time.

There are information systems under development that will be able to receive the information, process and then display it electronically but the data is still collected and communicated by humans. There is a need to develop a system of autonomously locating, identifying, and tracking the aircraft and then communicating the data to the new information system. This is a challenging task given the difficult shipboard conditions and constraints it must operate within.

The objective is to remotely acquire and track the location of each aircraft on the flight deck and hangar bay *by side number and type*, and present the information graphically in real time. This must be accomplished without altering the aircraft in any way (e.g. attaching bar codes to the fuselage, etc.). Technical challenges: (1) Aircraft are constantly moving and patterns of movement are unpredictable. Image recognition techniques must be able to acquire the salient characteristics (side number and aircraft type) of a moving target. It should be noted that side number can sometimes indicate the aircraft type, but this is not always the case, and building the redundancy of acquiring both would be required in any fielded system. (2) Aircraft are tightly packed and key edges and characteristics are frequently obscured. There is no tower high enough to give a "god's eye view" of either the flight deck or hangar bay where all edges of an aircraft can be seen. (3) The flight deck is approx 1080 feet long and 250 feet wide and can have the capacity for over 50 aircraft during operations. The hangar deck is approx 680 feet long and 108 feet wide and can have the capacity for 30 aircraft. The entire deck (either one) cannot be viewed by one single sensor. Rather sensor fusion techniques will need to be developed and applied. (4) Update rates would need to be fast enough to keep up with aircraft movement and display it smoothly without a "herky-jerky" motion.

PHASE I: Conduct a feasibility study which develops a concept for locating, identifying and tracking carrier embarked aircraft in real time. The concept must operate under severe shipboard conditions which includes: day, night, all weather, radio frequency/electromagnetic interference, and high clutter. The concept shall require little or no modifications to the aircraft (i.e. no electronic devices, etc.) and shall not interfere with flight and hangar deck operations.

PHASE II: Develop, test and operationally demonstrate the concept formulated under the Phase I effort on an aircraft carrier at sea.

PHASE III: Produce the concept as demonstrated in Phase II. The concept will be transitioned to the Navy's Shipboard Aviation Systems Development Program.

COMMERCIAL POTENTIAL: This technology has many applications in the commercial sector including: inventory control for Roll-On/Roll-Off ships, container ships and warehouses; and for supporting ground control operations at large commercial airports.

KEY WORDS: aircraft, tracking, identification, information systems

N98-047 TITLE: Passive Target Velocity Measurement System

OBJECTIVE: Develop a low cost, compact Fabry-Perot interferometric system in order to passively measure the velocities of multiple targets in a cluttered environment.

DESCRIPTION: The ability to passively measure the velocity of moving objects allows covert measurement for target tracking and discrimination in a littoral or air environment. In the past, Fabry-Perot interferometry has been used successfully to measure the velocity of shock loaded materials. In this approach interference fringes are superimposed onto a two-dimensional image of an extended scene that is illuminated by a laser source. Doppler shifts are imparted to light scattered off of moving objects within the

extended scene. The Doppler-shifted light passes through the Fabry-Perot etalon and fringes are formed. The pattern of the fringes change according to the magnitude of the Doppler shift. It is the intent of this proposal to demonstrate passive Doppler measurement using natural light sources.

PHASE I: Demonstrate technical feasibility through modeling for passive velocity measurement of moving objects in clutter; e.g. aircraft and missiles in a land and sea background. Luminosity throughput, resolution on F.O.V. and S/N with range are metrics of interest. The device should have large luminosity, high resolving power, and a wide field of view. It should also be able to measure the greatest possible velocity range and be frequency stable in adverse environments.

PHASE II: Develop a field system and demonstrate velocity measurements.

PHASE III: Demonstrate cost effective, compact, fieldable system.

COMMERCIAL POTENTIAL: Once developed, this system would have wide application for air turbulence avoidance, auto collision avoidance, space debris avoidance.

REFERENCES: A fixed etalon with an electro-optic material spaces may allow frequency stable operation over a wide velocity range.

KEY WORDS: Sensor, Fabry-Perot interferometry, Doppler shift

N98-048 TITLE: High Bandwidth, Secure, Portable, Wireless LAN

OBJECTIVE: Provide a secure/high bandwidth Wireless Local Area Network (LAN) for networking portable computing systems in a typical aircraft maintenance avionics environment.

DESCRIPTION: There are currently many efforts underway to move all of DON toward a complete digital aircraft avionics integration and maintenance environment. In response to the VISION state for the organizational (fleet) user, there have been several technology initiatives directed at flight line capable computer products. To date most of these efforts have used self contained data storage and processing to perform their tasks. Since the data and file storage necessary to perform avionics integration and maintenance can be quite large, another alternative is required for portable systems. The limitations of current technology are particularly apparent when the recall and storage of real time video and audio is required. Off loading the flight line system via a high speed (>20 Mbps) wireless network offers a logical solution. By making the portable unit a terminal on a network, the user could access database information available in the Automated Maintenance Environment (AME) and/or via "tele-maintenance" of real time audio, video and data to a remotely linked facility. Current state-of-the-art wireless LAN technology does not provide data transmission bandwidths greater than 10 Mbps. This project will exceed this current limit. This effort proposes to develop a wireless LAN technology that will permit multi-user, secure, real time video, audio, and data transmission between a flight line computing device and a remote central processing unit. The wireless LAN must maintain reliable communication between the participants while they are located within or shadowed by the aircraft, hanger, or shipboard structures.

PHASE I: Determine a wireless LAN technology innovation suitable for integration with PC based operating systems.

PHASE II: Design, develop, test and demonstrate a prototype system in a squadron level or flight deck operation environment.

PHASE III: Produce the operationally demonstrated systems designed during Phase II. These systems will be expanded to support the full transition to the AIR 3.0 vision state for digital technical data.

COMMERCIAL POTENTIAL: This wireless technology will offer the commercial (automotive and large machinery maintenance, power plant monitoring, fire fighting, remote medical triage) communities a mobile control capability for portable computers which is compatible with commercial software and processor hardware.

KEYWORDS: Wireless LAN's / Portable computer control / Secure communications

N98-049 TITLE: Portable Ground Based Solid State IFF Situation Display System

OBJECTIVE: Develop a system which utilizes solid state and phased array technology to capture RADAR Beacon Service (RBS)/IFF data and display such data in a manner which provides the UAV operator with a situation display showing the position of the UAV and other aircraft near the UAV.

DESCRIPTION: Unmanned Aerial Vehicle (UAV) operations require that the UAV operator have a knowledge of air traffic in the UAV operations area. A man portable system is needed to interrogate the airborne traffic in the UAV operations area and provide relative position data to the UAV operator. Current systems are not man portable and are cost prohibitive. The advent of small, solid state transmitter hybrid circuits and phased array antenna technology makes the development of this system feasible. Ground based processing of the UAV mounted collision avoidance and RBS transponders can provide the needed information to the UAV operator.

PHASE I: Provide a feasibility study which develops a method to interrogate and display the position of the UAV and other RBS equipped air traffic.

PHASE II: Develop, test and operationally demonstrate the methods formulated under the Phase I SBIR effort. Develop algorithms which automatically target unacceptable closure rates and angles to report collision avoidance alarms to the UAV operator. Provide field test units for integration into target UAV systems.

PHASE III: Produce manufactured units for use with designated UAV systems.

COMMERCIAL POTENTIAL: The low cost to acquire the system will make it attractive to smaller public airfields and automation of the collision avoidance feature will enhance flight safety.

REFERENCES:

1. MK XV IFF
2. FAA RADAR Beacon Service

KEY WORDS: IFF, Phased Arrays, Hybrid Circuits

N98-050 TITLE: Corrosion Avoidance Materials

OBJECTIVE: Conceive, develop, and demonstrate new or alternate materials and/or coatings that are corrosion tolerant or avoiding for aviation support equipment (ASE) in sea based environments.

DESCRIPTION: Corrosion of ASE internal spaces, ASE body panels, ASE electrical surfaces (i.e., grounding points), and other non-structural, non-critical require frequent maintenance. Stripping, surface preparation and repainting are costly, occupy scarce resources, impact readiness and add to the hazardous waste problem. This effort will conceive, develop and demonstrate new or alternative materials or coatings that are more resistant to corrosion and fouling.

PHASE I: The contractor shall conceive and describe several new or alternative corrosion resistant/avoidance materials and/or coatings (to be referred to as corrosion avoidance materials from hereon) for application to Naval ASE. Conceived materials shall include: (a) faster and less expensive stripping surface preparation techniques for maintenance; (b) be environmentally safe and compliant; © can be applied using techniques that are not hazardous to personnel or the environment; (d) benefits of utilizing such alternate materials; and (e) payback potential over the average life of the equipment.

PHASE II: Contractor shall finalize the selection of corrosion avoidance materials. Contractor shall select ASE components for application and demonstration, and determine their engineering characteristics to modify component designs to accommodate their manufacture from alternate materials. The contractor shall produce demonstration model components, and apply them on ASE for evaluation and demonstration purposes. The ASE shall be deployed on an active carrier or in a sea based environment for an evaluation period. Following deployment, the components' corrosion resistance and/or avoidance shall be evaluated and demonstrated.

PHASE III: The conceived corrosion avoidance materials will transition to the Naval Aviation Support Equipment Program Office (PMA-260C) for application to Naval ASE. In addition, the contractor will determine how the same materials/coatings can be applied to Naval ships and aircraft.

COMMERCIAL POTENTIAL: The conceived corrosion avoidance materials will have wide spread application in the Government, private, and public sectors. These materials can be applied to construction materials as well as transportation vehicles.

KEY WORDS: corrosion resistant; corrosion avoidance; materials; coatings; aviation support equipment

N98-051 TITLE: Electronic Schematic Archive

OBJECTIVE: Develop a methodology to automate the archival of electronic schematics in electronic format that is compatible to the Department of Defense (DoD) Automatic Test Systems (ATS) Computer-Aided Design (CAD) data base standards.

DESCRIPTION: The inventory of electronic schematics is heavily abundant with CAD data bases, IEEE standard schematic drawings, hand scribbles, and other unconventionally documented means, as well as in various sizes and dimensions. Due to the variety of formats, the access to, maintenance of, and revisions of these schematics is a costly logistics support burden (i.e., manpower intensive, manual intensive, time consuming). In some situations, these actions become unsuccessful which generate the need to redesign or backward engineer from actual hardware electronic schematics. These inventory efforts include the ability to interpret the various symbolic representations, i.e., wiring diagrams, nodal crossovers versus nodal connections, electronic components. This effort will introduce advanced technologies for automated interpretation and archival of electronic schematics (legacy, present, and new)of all known formats into electronic format. The electronic format will be compatible to the defined DoD ATS CAD data base standards to allow for future CAD use, such as, the development of test/diagnostic procedures/programs, and testability design. Significant logistic burden reductions for the access to, maintenance of, and revision of, and extended life expectancy of schematics are expected benefits from this effort. In addition, hooks will be provided for interface to the Joint Engineering Data Management Information and Control System (JEDMICS).

PHASE I: Determine the complexity and feasibility of archiving electronic schematics of all known formats into electronic format. The contractor will also conceive and describe the advanced technology application for automated archival of electronic schematics of all known formats. This includes: (a) a narrative list of known electronic schematic format types; (b) description of how each format type will be autonomously archived, including cost benefits; © required system architecture, including estimated return-on-investment; and (d) how the application will interpret symbolic representations. In addition, the contractor will provide a description of how the conceived technology application will interface with JEDMICS.

PHASE II: Demonstrate the technology application conceived in Phase I. The technology application shall be performed for each known electronic schematic format type.

PHASE III: Transition to the Naval Aviation Support Equipment Program Office (PMA-260D) for inclusion to the DoD ATS Program.

COMMERCIAL POTENTIAL: The commercial sector is heavily stocked with paper schematics of electronic circuits. There exists a strong drive to archive these schematics into CAD data bases. As with DoD, these schematics are either hand-drawn, unconventionally generated, or Institute of Electrical and Electronics Engineers (IEEE) standard compliant. Regardless, all of these schematics remain to be archived in electronic format into CAD data bases. Therefore, the commercial sector also needs an affordable technology application to automate electronic schematic archival into CAD data bases, and in a format mutually accepted between DoD and the commercial sector.

KEY WORDS: archival; electronic schematic; electronic format; CAD; automate; legacy.

N98-052 TITLE: Non-Cadmium Brush Touch-up Process for Cadmium Replacements (IVD Aluminum, Zinc Alloys, Molten Salt) Repairs

OBJECTIVE: To develop a selective plating formulation that contains more environmentally friendly constituents than standard cadmium electroplates, to repair scratched or breached surface plates. The new formulation shall meet the performance of the electroplate it repairs.

DESCRIPTION: Currently, due to the toxic and cancerous nature of cadmium a good deal of effort is now expended to find a replacement electro deposit(s)for electro deposited cadmium. These deposits invariably become scratched or breached requiring a touch - up repair.

PHASE I: Develop a non-hazardous elemental or alloy formulation(s) that meet current environmental laws/regulations and the performance requirements for its target application(s) at the Organizational and/or Intermediate maintenance level. Identify new formulations and potential applications. Conduct preliminary laboratory testing to demonstrate the feasibility of the new formulation(s) for its target applications.

PHASE II: Further develop a new electrochemical system meeting the objectives of Phase I results. Conduct both laboratory testing and field testing. The above testing shall demonstrate that the new electroplate meets all the performance requirements and environmental laws/regulations for target application(s). If necessary, propose amendment to existing government or commercial specification or propose new government or commercial specification for this electrochemical system to cover the technology.

PHASE III: Produce the electrochemical system demonstrated in the Phase II effort for both the military and commercial market.

COMMERCIAL POTENTIAL: The new electrochemical system can be used on commercial aircraft as well as non aerospace applications for both the government and private sector. Therefore, this technology is directly transferable.

KEY WORDS: Cadmium Replacement, Brush Plating, electroplating, touch - up, repair, Non-hazardous Pollutant

N98-053 TITLE: Develop Automatic Test System (ATS) Analysis and Configuration Management Tool

OBJECTIVE: Significantly reduce the cost of technology insertion with regards to Commercial Off the Shelf (COTS) and ATS modernization. Also reduce the cost of ATS comparison studies and Test Program Set (TPS) compatibility studies as precursors to ATS upgrade or replacement and TPS rehost.

DESCRIPTION: The proliferation of diversified test systems and test program sets have made it extremely expensive to upgrade testers, replace testers, and/or rehost TPS's. This tool would utilize the emerging Institute of Electrical and Electronics Engineers (IEEE) A Broad Based Environment for Test (ABBET) suite of standards to capture the information contained within a tester and the information contained within a TPS. The tool would further use the emerging standards to compare the compatibility of a TPS or suite of TPS's to a particular piece of Automatic Test Equipment (ATE). The output would indicate if a TPS or suite of TPS's could be hosted on the ATE, and, if not, what hardware would need to be added to the current ATE configuration to support the TPS('s).

PHASE I: Develop the requirements of the tool and identify framework issues, such as, platform, operating system, and languages to be utilized. Also identified will be target TPS's and ATE. This phase will also address the feasibility of utilizing the emerging IEEE standards based upon their content and availability. Besides the requirements and feasibility studies, the results of this phase will include a complete schedule for Phase II.

PHASE II: Utilizing the framework elements, ATE, and TPS's identified in Phase I, the analysis and configuration management tool shall be created and demonstrated.

PHASE III: The final phase will be the utilization of the tool created in Phase II on additional ATE and TPS's. This phase will include modifications to tester and TPS models required by the tool.

COMMERCIAL POTENTIAL: The commercial potential is high with respect to the infusion of COTS equipment into current ATE. The tools will be based on COTS tools and languages with a wide capability toward portability. This tool would be 100% dual-use with the ability to analyze commercial or military ATE and TPS's.

REFERENCES:
(1) IEEE Trial-use Standard for ABBET Overview and Architecture revision draft 16.0, 11 April 1996.
(2) IEEE Proposed Standard for ABBET Resource Management 6.4, 13 December 1996.
(3) IEEE Proposed Standard for ABBET Test Resource Information Model draft 2.1, 1 April 1996.
(4) DoD Acquisition Policy Document 5000.2R.

KEY WORDS: Test, Rehost, ABBET, Test Resource

N98-054 TITLE: A Simulation Tool for Forecasting Training Throughput and Resource Support Requirements

OBJECTIVE: Develop and demonstrate a simulation model (tool) capable of forecasting training throughput and resource support requirements.

DESCRIPTION: Successfully planning and managing USN training programs demands substantial analytical resources. The internal dynamics of changing training needs, combined with dynamic shifts in personnel, creates difficult scheduling, performance and cost tradeoffs in planning and managing the training process. These difficulties are caused, in part, by complex feedback relationships that define system behavior. A system dynamics computer simulation model of the cause-and-effect linkages underlying personnel movements and training processes would significantly facilities training needs. The model should also allow users to quickly investigate alternative "what-if?" scenarios, both to test assumed data points and to understand alternative training option tradeoffs.

PHASE I: Determine the feasibility of developing a training continuum simulation model running under Windows95 on a personal computer (PC).

PHASE II: Develop a dynamic training continuum simulation computer model that runs under Windows95 on a PC. Based on initial verification and validation results, expand and refine the model. Using government supplied data, apply the model to selected training programs to demonstrate the simulation model validity and utility. Provide the government with a completed application suitable for immediate use.

PHASE III: Disseminate to major system managers, BUPERS, CNET, and other training agents such as NAVAIR and NAVSEA for use in determining optimum training process, and student throughput and pipeline training requirements.

COMMERCIAL POTENTIAL: Many industries rely on extensive training programs to support required personnel skills. These companies would benefit from a simulation tool to assist in planing and managing training. Its use would also span other infrastructure and manpower system applications such as optimizing personnel strategies for both corporate and government entities.

KEY WORDS: Training; simulation; personnel; skills; modeling; system dynamics

N98-055 TITLE: Computer-based Training Conversion System

OBJECTIVE: Develop a comprehensive conversion system integrating a series of software and hardware components, which can predictably and consistently reduce both the cost and the lead time required to convert existing paper-based training systems into computer-based training (CBT) systems.

DESCRIPTION: A major portion of NAVAIR computer based training initiatives consist of converting existing courses into Interactive Courseware (ICW). To be most effective, this conversion process should take full advantage of existing training assets of these courses, re-engineer and complement these as required, and then use an authoring system to produce a highly effective ICW product. This can be a slow, expensive undertaking. A comprehensive process is needed to perform this task in a rapid, low-cost method which is predictable, repeatable, provides reusable ICW artifacts and is accessible to the wide range of organizations which may be expected to perform this work.

PHASE I: Conceive a comprehensive system to develop ICW from legacy training assets, validate this system and document lessons learned for users (ISD practitioners). The system feature open architecture; promote adoption of a common style guide; and, address inputs, through-puts, out-puts, operations and by-products off each step in detail. Validation shall be accomplished by using the system while converting a sample course module and significant metrics shall be collected. In this phase, the contractor may select his preferred components (Style Guide, file formats, scanner Authoring system, etc.). Lessons-learned shall address characteristics of legacy assets which produce the use of alternative branches within the process.

PHASE II: Expand the system developed in Phase I to be more compatible with various hardware and software characteristics commonly used in this discipline. Define the primary functional elements of the system, and define the characteristics of alternative hardware/software architectures which will effectively support the system. Validate the system on a larger sample of courses and collect metrics which substantiate that use of this system produces the desired savings of cost and time, resulting in a highly effective training development tool.

PHASE III: The contractor will develop a highly productive method of converting legacy training materials into ICW. Final enhancements to promote commercialization will focus on fine-tuning the system (potentially including software/hardware upgrades) to be effective in a full-scale production application.

COMMERCIAL POTENTIAL: The system described above is totally Dual-use, having as much application in commercial/private sector training organizations as in the Military. Academia, private sector education training firms, and in-house training units of major corporations are engrossed in projects to convert their paper-based course materials into ICW versions and will have strong interest in a rapid and highly cost effective integrated tool to assist them in this urgent task. This assures a strong commercial market for firms who develop systems meeting the requirements of this topic.

REFERENCES: MIL-HDBK-1379D

KEY WORDS: Computer-based Training, CBT, Interactive Courseware, (ICW), Intelligent Tutoring systems, Data Conversion

N98-056 TITLE: Helicopter Weapon System Emulation Model

OBJECTIVE: The need exists for an ASW helicopter weapon system emulation model. The model will be used by program personnel to develop system understanding and to identify requirements for system improvements, man-machine interface changes, training and trainers. This tool will facilitate program tradeoffs and will provide lead time for necessary on-board computer system improvements.

DESCRIPTION: Development of a low cost modular software system to emulate a modern helicopter weapon system.

PHASE I: Develop a generic helicopter weapon system emulation model written with a COTS graphical user interface.

The emulator is to be hosted on up to three personal computers on a LAN. The weapon system design shall be assumed to be a COTS, modular, open architecture hardware and software design with a number of on-board sensors including radar (with SAR/ISAR), IFF, ESM, acoustics (both sonobuoys and dipping sonar) and IRDS/LLLTV. A generic automatic flight control system as well as modern generic self protection, stores, navigation and communication systems shall be incorporated in the model. Programmable on-screen key sets shall be used to control system components and sensors. Incorporated in the model shall be a system resource estimator that outputs computer resource requirements in various system multimode scenarios.

PHASE II: Develop, demonstrate and test a full weapon system emulator that includes simulated weapon system operations including sensor displays, target tracks, false alarms, and weapons deployments. Host the emulator on a COTS UNIX-based work station.

PHASE III: Use the technology developed in Phases I and II to produce a new class of low cost, highly adaptable system emulators and trainers. New methodology will allow for rapid system upgrades when new sub-systems or sensors are added to weapon systems in the future.

COMMERCIAL POTENTIAL: New system emulation technology can be used to develop control systems for a variety of commercial applications including manufacturing facilities, petroleum and chemical plants, and electrical power distribution and management.

KEY WORDS: Weapon System Emulator; helicopter; modular; software

N98-057 TITLE: Advanced Training Technology Delivery System

OBJECTIVE: Develop comprehensive training technology for use in training facilities using innovative delivery methods that will provide maximum leverage of technology projected to be available in the 21st century.

DESCRIPTION: Innovative techniques are solicited to deliver training via the Internet and Intranets using and integrating commercial off-the-shelf (COTS) equipment. Currently, this is only achievable utilizing standard desktop computers which are very costly and involve a high life cycle management and maintenance expense. The emphasis of this solicitation must be placed on (1) novel approaches and concepts for delivering training Computer Aided Instruction (CAI) and Interactive Courseware (ICW) over networked resources in a Client/Server environment using Intranets and the Internet, (2) support the delivery of Video On Demand (VOD) over the Intranet while assuring Quality of Service (QOS), (3) use an network system architecture conforming to open standards, (4) utilize low cost student terminals, (5) integral system software configuration management, (6) provide an instructor station capable of monitoring student activity, (7) incorporate electronic whiteboard technology, and (8) allow the automated updating of remote curricula via the Internet. This system must use emerging BISDN technology, low cost network devices, support both new and legacy curricula, and afford the delivery of instructional curricula to all systems attached to the Internet or Intranet. It is highly desirable that this system allow the direct reuse of software developed for aircraft systems to further reduce training acquisition costs and life cycle updates consistent with the currently fielded aircraft model versions.

PHASE I: Provide an exact description of the system to be designed, including proposed hardware, software and cost. Propose a means of measuring the systems ability to perform the task of delivering video and CBT over an Intranet.

PHASE II: Produce a viable prototype system and demonstrate its ability to support curricula over an Intranet.

PHASE III: Transition the technology to aviation schoolhouses and operational field activities over both Intranets and Internets.

COMMERCIAL POTENTIAL: Due to the ever increasing costs of travel expenses, distance learning is becoming essential in today's commercial environment. By allowing proficiency training over an intranet (or exported via the internet), schools, companies, and any organizations can conduct multi-faceted training on site instead of costly off-site courses. By utilizing a server-based network, and incorporating the innovative technology proposed in this SBIR, companies could take advantage of this training approach without the normally high life cycle costs (i.e. configuration management) associated with standard PC based network devices.

KEY WORDS: Distance Learning, Aircraft Training, CBT, High Bandwidth Telecommunications, Adult Education.

N98-058 TITLE: Imagery Database Retrieval and Indexing

OBJECTIVE: Develop new content addressable techniques for retrieval and indexing of imagery databases.

DESCRIPTION: One of the most important emerging computing technologies is the management of visual information. Processing

of visual information requires management of large volumes of non-alphanumeric information, computations, communications, and visualization of results. As images are being generated at an ever-increasing rate, content-based information retrieval systems can effectively and efficiently organize (index) and retrieve visual information from large databases consisting of both textual and imagery information. Searching image databases using image queries is a challenging problem. Since information contents may include pictorial information to allow for multimedia applications and visualization, there is a need to query large on-line image databases using the image's content. In order to accomplish this, the objective of this project is to develop new querying techniques for imagery databases.

This project shall explore the following new aspects and their resulting techniques integration into a unified search and indexing engine: (I) the derivation and computation of the most optimal attributes ('features') of images and visual objects that can provide useful query functionality for search and retrieval, (ii) adapting ('learning') user profiles for better performance, (iii) the development of retrieval methods based on similarity as opposed to exact match, (iv) query by image examples or user drawn images, (v) development of the pictorial querying language, design of the user interfaces, and (vi) query refinement and navigation.

PHASE I: Develop innovative concepts of content-based image retrieval, develop a search and indexing engine, and provide its initial experimental feasibility proof.

PHASE II: The Phase II would provide a beta version of the Phase I developed software system and its demonstration. As the test-bed for the Phase II effort, imagery databases maintained by the Navy will be used (imagery databases used by naval simulators, target imagery databases).

PHASE III: During Phase III, the prototype will be fully scalable to support the commercialization of the product.

COMMERCIAL POTENTIAL: Software products resulting from this project can be used by various media commercial entities in such application areas as: FBI mug shots databases, medical imaging databases, media databases, and multimedia databases maintained by press agencies.

Key Word: Imagery Database, Image Retrieval, Image Indexing

N98-059 TITLE: Interactive Part-Task Training Over Local Area Networks (LANs) and the Internet

OBJECTIVE: Develop new software environments for semi-automatic rapid prototyping of part task trainers.

DESCRIPTION: The current developmental efforts for the part-task trainers confront several problems in the face of incremental advances in computer technology. Forward-Compatibility: The part-task trainers software is usually written in machine dependent programming languages for platforms that are currently unacceptably slow for the tasks demanded of them. Storage, Access, and Retrieval: Databases of part task trainers are usually very large (e.g. large target imagery databases). Security: Since target databases are classified as secret, security of the database and training system is required; however current systems can be easily accessed, copied, distributed, or modified. Portability: The machine specific codes in most cases need rework or recompilation in order to run on different systems. In order to fully address the concerns of forward-compatibility, storage, access and retrieval, security, and portability current rapid prototyping environments depend strongly on tedious and manual programming efforts. The main objective of this project is to automate a large portion of the prototyping process by introducing knowledge base and expert system techniques integrated with an object oriented paradigm. The developed approach will be used to analyze users requirements and automatically generate a "prototyping road map" accompanied by a library of re-usable components.

PHASE I: Investigate capabilities of current technologies for part task trainers prototyping. Develop a concept for the new part task trainer development environment.

PHASE II: Develop and implement beta prototypes for two part task trainers utilizing the Phase I developed environment.

PHASE III: Transition the Phase II systems to the multimedia authoring system for creating adaptive and interactive part task trainer development environments using the Internet technology.

COMMERCIAL POTENTIAL: The need for robust and current training systems is in great demand not only in the military but also in educational centers throughout the world. The software system resulting from this project can be easily modified to address the training needs of great many computer aided learning systems. It will serve several of the computer-based instruction industries, the computer network industry, and the interests of generations of students, educators, and trainees.

Key Word: Part Task Trainer, Authoring System

N98-060 TITLE: New Techniques for Compiling Multiresolution Terrain Representations

OBJECTIVE: Develop new technologies to automate synthesizing spatial objects from terrain databases at various levels of resolution to support the next generation of force representation simulations.

DESCRIPTION: A simulation may be regarded as composed of interacting objects that represent real-world entities. These objects can correspond to physical entities at various levels of abstraction. Interaction between objects is achieved by different execution mechanisms. Given that objects provide the fundamental units of simulations, the high-level architecture indicates the basic ways in which these objects will be generated and will interact with one another in a synthetic environment. Most of the current work on synthetic environment generation is concentrated on the generation of large virtual worlds utilizing virtual world databases. Examples of such systems include advanced distributed simulation including Simulator Networking (SIMNET), Battlefield Distributed Simulation (BDS-D) and Close Combat Tactical Trainer (CCTT); High-fidelity training simulators represented by the Special Operations Forces Aircrew Training System (SOF-ATS); Unmanned Ground Vehicles (UGV); and the development of detailed site models for automated imagery analysis (RADIUS). The spatial data requirements for many simulation programs generally include significant augmentation of standard products produced by the Defense Mapping Agency to address critical issues of timeliness, local geographical intensification, and operational security. They currently rely largely on manual and interactive compilation, which are labor-intensive and not well suited to demands of responsive database intensification and maintenance. The goal of this project will be to explore innovative and creative technologies that automate the process of synthetic terrain compilation.

PHASE I: Provide proof of feasibility for the proposed concepts.

PHASE II: Demonstrate and validate the most promising techniques for compiling multi-resolution terrain representations.

PHASE III: Enhance the Phase II prototype and implement final product(s) that can be interfaced with the government suggested synthetic virtual simulation environment(s). The final product will constitute the software library of various tools for compilation of terrain representations. The capability of porting these software tools to various simulation platforms will be an essential part of the final Phase III delivery.

COMMERCIAL POTENTIAL: The technology for automatic terrain generation in simulated environments will result in commercial tools that can be utilized across various domains. For example, they can be used by the computer game industry for rapid-prototyping of realistic terrain representations and by the entertainment industry for cost effective rendering of special effects in the movie production process.

REFERENCES: Defense Modeling and Simulation Office Program Master Plan, Marine Corps Modeling and Simulation Master Plan

KEY WORDS: Virtual Reality, Synthetic Environment Generation, DIS, Modeling, Simulation

N98-061 TITLE: Real-time High Fidelity Image Synthesis for Virtual Reality-Based Trainers

OBJECTIVE: Generate high fidelity, high resolution images in real time for virtual reality (VR)-based trainers

DESCRIPTION: The full potential of virtual reality-based trainers is far from being realized, largely because the available synthetic imaging technology is computationally intensive, slow, and yields low resolution images. In order to react in real-time to head and eye movements of the viewer, the image synthesizer must severely compromise image fidelity for the sake of speed. Even with these compromises, image generation often lags perceptibly behind head and eye movements, often inducing simulation sickness.

Although capable of producing high quality images, conventional ray tracing algorithms are too slow for real-time image synthesis: thousands of rays must be traced from illumination sources through the medium to an image plan in order to form a high fidelity image. An alternative based on Gaussian beam tracing and helmet eye-tracking technology has some promise for overcoming these limitations.

The notion of exploiting the very limited resolution of the human eye (except in the retinal region called the fovea) has been explored. Using eye tracking technology and rendering only the few degrees in the field of view of the fovea, computational requirements on the image synthesizer can be reduced from hundreds of thousands down to a few hundred. This is not yet sufficient, however, to allow fully real-time image synthesis. Coupling this approach with Gaussian beam tracing as an enabling technology, however, shows the potential to reduce the number of computations to fewer than a hundred, which would be within the capability of affordable systems.

PHASE I: Develop and document the technical approach to a proof-of-concept technology demonstration.

PHASE II: Develop and demonstrate a prototype proof-of-concept system.

PHASE III: Transition prototype Gaussian beam based VR rendering and image generation system into a portable software

package suitable for direct commercial and DoD applications. Develop interface specifications that will allow hardware vendors to develop software driver packages. Specifically, develop interfaces for an AH-1W Aircrew Procedure Trainer (APT) with product applications available for commercial aviation trainers as well as military heavy equipment training.

COMMERCIAL POTENTIAL: Training systems in all aspects of government and industry will move to VR when the technology satisfies the business case. This technology can also apply to the entertainment industry as well as computer-aided design and prototyping.

KEY WORDS: Virtual reality, helmet-mounted display, training systems, ray tracing, image synthesis, Gaussian beam

N98-062 TITLE: Aluminum Nitride Infrared Window

OBJECTIVE: Develop a method to produce aluminum nitride seeker windows that are transparent in the 3- to 5-micron wavelength infrared region.

DESCRIPTION: Sapphire is the current material of choice for midwave infrared seeker windows on high speed missiles because it has the greatest thermal shock resistance of any available window material. Materials with twice as much thermal shock resistance are required for hypersonic missiles that are currently being planned. Aluminum nitride can potentially meet this requirement. Aluminum nitride has a strong birefringence, which has so far prevented the fabrication of transparent polycrystalline materials. Birefringence causes significant optical scatter which cannot be tolerated in a seeker window. The goal of this program is to fabricate aluminum nitride with a thickness of 2 millimeters, less than 2 percent scatter at a wavelength of 4 microns, an absorption coefficient less than 0.1 per centimeter at a wavelength of 4 microns, and a thermal conductivity above 160 watts per meter-kelvin at room temperature. Aluminum nitride windows should allow an increase in flight speed by about 1 Mach over sapphire windows.

PHASE I: Demonstrate the feasibility of fabricating aluminum nitride with at least 65% transmittance at a wavelength of 4 microns when the thickness is at least 1 millimeter.

PHASE II: Refine the process to prepare aluminum nitride disks with dimensions of at least 2 millimeters thickness and 25 millimeters diameter with the following properties: < 2% scatter at 4 microns; absorption coefficient < 0.1 per centimeter at 4 microns; and thermal conductivity > 160 watts per meter-kelvin 20øC. Material meeting the optical requirements will have a transmittance of 74% at 4 microns. Measure the mechanical strength of optical quality disks (25 mm diameter x 1.5 mm thick) using ring-on-ring flexure. Strengths should be measured on 20 disks at 20øC and 20 disks at 600øC. Target strengths are >200 megapascals at both temperatures.

PHASE III: Transition fabrication technology into a production facility capable of manufacturing 90-millimeter-diameter hemispheric domes (thickness = 2.5 mm) or flat rectangular windows with dimensions up to 100 mm x 200 mm (thickness = 5 mm) for use in a selected hypersonic missile system. Establish a database of physical properties including thermal conductivity, mechanical strength, modulus, expansion coefficient, and optical absorption coefficient as a function of temperature up to 1000øC. Develop an antireflection coating that provides >90% transmittance in the wavelength range 3-5 microns for 2.5 mm thick parts coated on both sides. Measure the change in transmittance of bare aluminum nitride and antireflection-coated aluminum nitride in rain and sand erosion experiments.

COMMERCIAL POTENTIAL: High purity/density aluminum nitride will be available for military and civilian applications (such as process monitoring) involving high thermal loads on optical windows, or as a substrate for high performance electronic devices.

REFERENCES:
1. D. C. Harris, "Infrared Window and Dome Materials," (ISBN 0-8194-0998-7) SPIE Press, Volume TT10, 1992

KEY WORDS: ceramics, aluminum nitride, thermal shock, infrared window, infrared dome; infrared seeker

N98-063 TITLE: Durable, Transparent, Electrically-Conductive Coatings

OBJECTIVE: Develop a durable, infrared-transmitting, electrically-conductive coating for a high-speed sapphire missile dome.

DESCRIPTION: Durable, electrically-conductive coatings are needed to replace the metallic mesh designs currently used to control electromagnetic interference (EMI) and radar cross section on missile domes and sensor windows. Mesh coatings made from soft metals like gold and copper provide effective shielding but are easily scratched and are not durable enough to be applied to the external surface of the sensor window where they would be the most effective. A mesh applied to the external surface of sapphire

should be at least as hard as sapphire. No dip-coated materials will be considered for this application due to the extreme durability requirements of a high-speed missile dome.

The requirement is to achieve greater than 20 decibels of shielding from 400 MHZ to 18 GHz while maintaining at least 90% transmittance through the coating in the mid-wave infrared from 3 to 5 microns. These requirements are easily achieved with a metal grid or mesh coating. However, a mesh can only be designed to provide a given level of shielding for a specific range of EMI frequencies. Grids also degrade the off-axis optical performance of the seeker. It would be better to eliminate the grid structure entirely and use a continuous coating that has both the required electrical conductivity and infrared transparency.

PHASE I: Identify promising materials and coating processes. Fabricate witness samples of the most promising materials for preliminary characterization of electro-optic performance and evaluation of erosion-resistance.

PHASE II: Demonstrate a cost-effective, large-area, uniform coating process for simple and complex shapes. Provide samples for validation testing of electro-optic performance and impact resistance.

PHASE III: Production capability for depositing electrically-conductive, durable, optical coatings on missile domes and aircraft windows

COMMERCIAL POTENTIAL: Similar technology is required for optics, sensors, and photovoltaic arrays on commercial satellites where electrical charging and space-debris/micrometeoroid-impact damage severely limit the useful life cycle. Durable coatings are needed for fiber optic sensors used in severe chemical environments such as automobile and industrial pollution monitors. Electrically-conductive, durable coatings could be used to provide lightweight EMI shielding in many commercial products where electronic noise is a problem.

REFERENCES: MRS Bulletin, Applications of Intermetallic Compounds, May 1996, Volume 21, No. 5

KEY WORDS: sapphire missile domes, EMI shielding, reduced radar cross section, transparent conductors

N98-064 TITLE: Low-Cost, High-Fidelity, Portable UCAV Simulation

OBJECTIVE: To obtain a capability to cost-effectively simulate and test Uninhabited Combat Air Vehicle (UCAV) air-to-air and surface attack maneuvering tactics and UCAV control paradigms in realistic scenarios.

DESCRIPTION: The UCAV is a new and promising multi-role/multi-mission (air-to-air and air-to-surface) Naval weapon system concept. To obtain the full benefit of such a weapon system, air-to-air and surface attack tactical options and UCAV control paradigms must be explored. Because this new weapon system can be used in ways that were previously not possible, many new and different tactical options must be studied. Cost is always an issue - the ability to explore many types of tactics and control paradigms inexpensively is required.

Advances in personal computer (PC) systems make them suitable for some applications which were previously only addressable by sophisticated, expensive dome simulators. The use of PCS for such an application will result in a semi-portable dome simulator-like capability for a fraction of the cost.

If properly designed and built, a PC-based UCAV simulation would be an excellent tool for the analysis of UCAV tactics. Such a simulation could also be used as an environment in which various UCAV control paradigms could be tested and as a low-cost training tool for UCAV controllers/operators.

PHASE I: Analyze the feasibility of developing a PC-based, multi-station, high-fidelity, distributed air combat maneuvering (ACM) simulation capability in which each station simulates a UCAV or a manned threat aircraft. Some of the desired capabilities of such a simulation are: (1) all UCAVs, manned aircraft and weapons should be modeled at the six degree-of-freedom level of fidelity; (2) UCAVs should be modeled as aircraft-like vehicles with a high maneuver capability; (3) station setting (UCAV or manned aircraft) should be menu-selectable; (4) each station should have a reasonable cockpit-like feel (throttle and stick, virtual console switches) and possess virtual reality goggles to show the pilot a cockpit display, heads-up display, scene, etc.; (5) frame rates and time lags should not be noticeable; (6) simple sensor models would be acceptable, but the possibility of higher fidelity sensor models should be investigated. If such a simulation is feasible, then one goal would be to use it to study UCAV algorithms which would allow the UCAV to fly autonomously, detect, track, identify and engage targets, send engagement information to a human controller, and receive final firing authority and other high-level commands from the human controller. Therefore, the analysis should address the possibility of allowing one or more UCAVs to be flown by computer (rather than by an operator at one of the stations), perhaps even to the point of allowing actual UCAV flight software to be implemented at some point. It should also address the possibility of including a human controller station and allow for the inclusion and testing of various UCAV control paradigms. Also, because it would be desirable to use the simulation to study the attack of surface targets by the UCAV, the analysis should address this possibility.

PHASE II: Develop, test and demonstrate the simulation based on the feasibility analysis performed under the Phase I

SBIR effort.

PHASE III: Provide the simulation to current and proposed Navy UCAV projects.

COMMERCIAL POTENTIAL: If feasible, the simulation could be used to provide a low-cost flight simulation tool which would permit a number of students and air traffic controllers to train together in a realistic, multi-element environment. Given sufficient capability, such a simulation could be used as a lower cost alternative in many applications in which only dome simulators could be used previously, such as manned military and commercial aircraft trainers, and in some applications which have traditionally required full scale range tests.

REFERENCES:

1. "Technology Related to the Highly Maneuverable Lethal Vehicle (HMLV) Concept", DTIC Publication: AD-B217136

KEY WORDS: UCAV; 6-DOF; models and simulations; multi-station; training; analysis

N98-065 TITLE: Accelerometer-Based Multi-Sensor INS

OBJECTIVE: Develop an extremely low-cost inertial navigation sensor using only low-cost accelerometers, without any gyros, that provides high accuracy through the use of robust statistical point estimation.

DESCRIPTION: The potential exists to measure attitude and acceleration with only accelerometers. An inertial sensor based on such a configuration would have significant cost advantages over one based on gyros, since there are already extremely low-cost micro-machined accelerometers on the commercial market. However, there is still some work to be done in developing the algorithms for such a sensor system. In order to improve accuracy, there would be a large number of sensors per channel. The inputs to these sensors would be collected simultaneously and combined in a statistically robust, static point estimate. Point estimation would be required to avoid the use of filters that would create lags and contaminate the inertial outputs for use with other sensors in another filter, thereby avoiding the problem of filter driving filter. Robust estimators would be used to avoid requiring inordinately large numbers of sensors per channel.

PHASE I: Develop mathematical algorithms for combining accelerometer inputs to provide both attitude and acceleration for inertial navigation. Develop the robust statistical point estimators necessary for combining the measurement per input channel. Demonstrate with simulations that these algorithms work and through analysis show that they can be implemented in real-time on an existing platform. This analysis must include all the requirements and the design for a workable real-time device suitable for embedded applications.

PHASE II: Build a prototype device, including the sensors, processor, and software implementation suitable for real-time testing in a high dynamic environment.

PHASE III: Develop INS packaged for embedded applications for stand-alone navigation or for integration with other sensors, including GPS.

COMMERCIAL POTENTIAL: Besides the military applications for weapons systems and training ranges, an extremely accurate, very low cost inertial navigation system built with rugged, easily obtained micro-machined accelerometers and no gyros would have enormous utility in commercial, military, and general aviation as well as in land vehicle navigation and robotics.

REFERENCES:

1. Buford W. Shipley and Donna Jo Boughn, Evaluation of sensor systems for measuring rotational motion, Proc. 31" Annual SAFE Symposium, 1993.

KEY WORDS: GPS, INS, Accelerometers

N98-066 TITLE: Shape Charge Warhead Effectiveness Simulation, Including the Resultant Effects when Coupled with Current Shaped Charge Countermeasures.

OBJECTIVE: To develop a method to simulate the effectiveness of various shaped charge warhead designs in penetrating hard targets, to include performance in the presence of various countermeasures.

DESCRIPTION: Shaped charge warheads in current and planned weapon systems may be countered by a variety of techniques. This project seeks to optimize shape charge warhead design by modeling warhead performance and its countermeasures effects.

PHASE I: Determine the feasibility of developing a computer model or simulation that will accurately predict shaped charge warhead effectiveness in the presence of various types and amounts of countermeasures.

PHASE II: Develop and demonstrate the simulation model and its ability to precut countermeasures effects using data to be provided by government field activities. The model predictions must accurately reflect actual test results of armored vehicle countermeasure system effects(e.g. reactive Armor, Spall curtains) when hit by a TOW/HELLFIRE anti-armor type warhead.

PHASE III: Validate simulation model by a series of tests of the "then" configuration of the Joint Standoff Weapon (JSOW) penetration/Blast Warhead variant. The JSOW Penetration/Blast Warhead variant developed is expected to coincide with this SABIR effort, and will be critical to simulation model validation.

COMMERCIAL POTENTIAL: The resulting model or simulation could be used to predict the effects of various shaped charge explosives used in demolition, mining, "down-hole" oil well pipe perforation and construction.

REFERENCES:
1. Joint Operational Requirement for Joint Standoff Weapon (JSOW) System, USN Serial 301(1)-88-94
2. Department of the Navy Science and Technology Requirements Guidance, June 1996

KEY WORDS: Shaped Charge, Explosive, countermeasures, Warhead, simulation

NAVAL SEA SYSTEMS COMMAND

N98-067 TITLE: Wideband Fine Frequency Measurement

OBJECTIVE: To develop a wideband fine resolution frequency measurement apparatus for application in Electronic Support Measures (ESM) and EW Countermeasures (ECM) receivers.

DESCRIPTION: Wideband Fine Frequency Measurement (FFM) achieves a frequency resolution of 0.5 MHZ with an overall accuracy of 1.0 MHZ (RMS), allowing separation and measurement of closely-spaced signals in congested operating bands containing CW and copulse emissions. Pulse-by-pulse measurement capability over instantaneous operating bandwidths exceeding 500 MHZ at a sustained composite environment pulse-processing throughput of 7 Mpps is desired. On-pulse frequency measurement with minimum latency is a critical ECM requirement. This effort will fabricate and test a demonstration FFM unit suitable for rapid integration and field testing in support of current and planned EW/ESM and ECM systems, and to exploit commercialization opportunities.

PHASE I: Several promising approaches employing advanced technologies will be evaluated and based on these results, one selected approach will be pursued to the brassboard demonstration level in Phase II. Technical feasibility, maturity of the technology, availability of evaluation devices, and estimated production cost will serve as decision criteria justifying further investigation. One selected approach will be demonstrated in breadboard form and thoroughly tested to ensure performance goals can be achieved and identify/correct limiting factors.

PHASE II: Design, fabricate and test a fully functional brassboard model of the FFM unit. This effort will provide the primary FFM hardware deliverable with embedded software and external interfaces. FFM operational functions including configuration, calibration, status reporting, and measurement data collection will be performed under control of an external COTS personal computer. Bench, RF simulator, and limited field testing will be performed to characterize FFM performance under a variety of signal environments. An ESM (or ECM) receiver compatibility/integration test is intended to demonstrate a system-level performance benefit resulting from FFM.

PHASE III: Transition FFM technology into a DOD and/or commercial product. The effort will repackage the FFM unit for operational (shipboard) environments, and provide electrical interfaces compatible with the selected ESM (or ECM) system application. Test and evaluation of system-level performance under complex RF simulator and field environments will be performed.

COMMERCIAL POTENTIAL: Wideband Fine Frequency Measurement technology has anticipated application in several product areas including RF test equipment, frequency band monitoring, dynamic allocation of spread-spectrum transmission channels, and identification of unknown signal types (for law enforcement agencies).

REFERENCES:
1. Tsui, J. B. "Microwave Receivers with Electronic Warfare Applications", John Wiley & Sons, 1986, p180.
2. Levitt, H. L., Alexander, E. M., Tse, A. Y., Spezio, A. E., “Super Resolution Precision Direction-Finding Techniques and Measurements”, SPIE Aerospace Sensing and Control Symposium, Conference #2489, Orlando FL, April 18, 1995.
3. Polkinghorn, F. Jr., Farnham, H. "Ambiguity Resolution in the SPASUR Radio Interferometer Direction Finding System", Naval

Research Laboratory Report 6603, Oct. 12, 1967.

KEYWORDS: situation awareness; electronic warfare; receiver; frequency; countermeasures; wideband

N98-068 TITLE: Real Time Software Upload/Download via Satellite

OBJECTIVE: Design and demonstrate a Real Time Software Upload/Download via Satellite for the purpose of making ship software deliveries and upgrades. This capability will permit a Software Support Agency (SSA) to transfer software directly from its offices to shipboard computers by means of Direct Broadcast Satellite (DBS) services.

DESCRIPTION: The major effort of this SBIR will be the development of a low-cost, prototype software delivery system; prototype demonstrations will be delivered in discrete phases. A major focus will be placed on the maintainability, usability, and integration of this ability with currently installed shipboard systems and present logistical processes.

The technical challenge is designing the software architecture so that it will work on existing ship-to-shore links and tightly integrated into the current shipboard computer systems and logistics procedures. This innovative approach will give platforms the ability to request a new download of software programs and/or data, which will eliminate the delay associated with the physical transfer of media, and the scheduling of maintenance personnel and activities. An early prototype will consist largely of Commercial Off The Shelf (COTS) components, although a trade study will examine whether eventual implementations can take advantage of the proposed Global Broadcast System (GBS) or other shipboard satellite systems.

PHASE I: Develop a design for a software upload/download satellite link, compatible with existing peripherals. Determine the required channel bandwidth, data throughput, encryption techniques, handling procedures and time latency for making timely software data deliveries. Frequency and effective radiated power will be handled by the satellite terminal and are not a design criteria. Deliverables will include the operational concept, system requirements, and system architecture for a prototype system, and a plan for testing the prototype.

PHASE II: Develop and test and demonstrate a prototype system conforming to the design of Phase I. The prototype will be designed and integrated into an actual SSA software delivery path and include computer equipment from representative hardware platforms. Demonstration will include data transfer, file encryption, and software installation. Deliverables include the prototype, development documents, user documents, test procedures and test results.

PHASE III: Conduct an operational test and evaluation between the selected SSA and a ship at sea using a second generation system to include an operational software package. Upon successful completion of Phase III, the capability will be ready for production and operational deployment by the Navy.

COMMERCIAL POTENTIAL: A commercial variant of this system can be developed for deploying custom-developed software and data for business transaction processing for geographically distributed businesses.

KEY WORDS: Satellite Link, Software Support, Direct Broadcast Satellite, Global Broadcast System

N98-069 TITLE: Low-Cost Nozzle Throat for High-Performance Tactical Missiles

OBJECTIVE: Develop a low-cost material, including fabrication approach and supporting property and performance design information, which provides zero-erosion performance in highly-aluminized propellant environments.

DESCRIPTION: Current high-performance tactical rocket nozzles, such as used in the Mk104, utilize multi-component construction with a tungsten throat. Although the tungsten throat provides satisfactory performance, significantly improved design flexibility, reduced cost and complexity (with attendant improved reliability), and improved nozzle efficiency is believed possible with ceramic matrix composite (CMC) materials. For example, a one-piece CMC nozzle shell could reduce overall motor cost by reducing the number of components and assembly cost. The need exists to: 1) define composite architecture (composition which provides zero erosion and reinforcement design which handles pressure and thrust loads, and thermal stress resistance); 2) develop low-cost processing technique; 3) verify material capability via proof-testing; and 4) develop analytical modeling and a property data base sufficient for design use.

PHASE I: Define a composite architecture and identify a composite processing approach to provide the described characteristics, above. A fabrication approach shall be also defined and cost estimated for production-level quantities. Perform experiments critical to verifying both architecture and processing and produce analytical predictions and/or experiments to provide high confidence of satisfactory demonstration of the fabrication approach in phase II. For example, critical chemistry and structural properties shall be defined and verified. The proposed processing approach should reflect a strong understanding of the material

requirements (eg., thermal, chemical, mechanical) imposed by the rocket nozzle environment. Implementation of continuous-fiber-reinforced CMC nozzle shell geometry technology is suggested and preferred.

PHASE II: Develop and demonstrate the fabrication/processing approach, and verify the fabrication approach, defined in Phase I. Produce representative nozzle shells and demonstrate prototype component performance. Models (structural, oxidation, etc) initiated in phase I shall be verified experimentally. A materials property data base shall be initiated.

PHASE III: A full nozzle demonstration shall be performed and materials property data bases shall be completed.

COMMERCIAL POTENTIAL: The developed material fabrication approach would have broad application to the manufacturing of low-cost, high-temperature structural materials. For example, both liquid and solid propellant motor components for commercial satellites (orbital transfer missions) and earth-to-orbit vehicles could be produced at significantly lower cost and higher performance. Improved satellite station-keeping thrusters could significantly reduce satellite system cost by optimizing motor performance to enable longer satellite lifetimes. The materials fabrication approach could also be utilized to significantly reduce the cost of leading edge and nosecap materials for earth-to orbit and hypersonic transport vehicles. Finally, the fabrication approach could be utilized to inexpensively produce thermal-stress-resistant refractory materials such as those used as anodes for aluminum production.

REFERENCES:

1. Opeka, M.M., "Oxidation-Resistance and Utilization of Refractory Compounds. II. Thermodynamic Response Predictions for Solid Propellant Environments," Proceedings of 21st Annual Conference on Ceramic, Metal, and Carbon Composites, Materials, and Structures, Adv. Matls. and Processes Tech. Info. Analysis Center, Rome, NY, 1997.

2. Lally, F.T., et al., "Carbides for Solid Propellant Nozzle Systems," AFRPL-TR-68-164, 1 Oct 1968. (DTIC AD-843084)

3. Hawkins, D., et al., "Hafnium Carbide Matrix / Carbon Fiber Composite Payoff Study - Tactical and Strategic Missile Propulsion Applications," NSWCDD/TR-96/74, April 1996. (Avail DTIC)

KEYWORDS: tactical missiles, solid rocket motors, rocket nozzles, refractory materials and composites, low-cost composite fabrication, zero erosion, tungsten

N98-070 TITLE: Active Antenna Design Concept Using Microwave Power Modules

OBJECTIVE: Develop a design for military, air-cooled, active phased array antennas to be installed on multiple platforms using Microwave Power Module(MPM) technology.

DESCRIPTION: MPMs appear to offer an advantage in military RF systems because of their higher efficiency, high power, air cooled operation and relatively small size and weight. Current Cooperative Engagement Capability (CEC) Antennas are heavy, require liquid cooling lines in the ship mast, and extra ship space for Environmental Control Units (ECU). An MPM type, ship mast-mounted antenna application could be implemented without external cooling, offering much needed weight reduction compared to active, liquid cooled arrays. These antenna could also be used for land based sites, vehicles or modified for air platforms.

PHASE I: Develop active phased-array design concepts reflecting effective use of MPMs. MPM parameters shall be furnished by the Government. Specifications for frequency, pattern quality (sidelobe level), and bandwidth etc. require the contractor to have a secret clearance. Technical data on current antennas is available. MPM technology is under development at the Naval Research Laboratory (NRL). Design concepts shall be provided for active shipboard antenna and other platform applications for government selection in Phase II.

PHASE II: Develop a detailed preliminary design for a full shipboard CEC antenna, based upon the Phase I concept design and the MPM configuration selected by the government. The design shall be accompanied by performance analysis, and comparisons to the existing CEC active antenna. A cost analysis shall also be performed. Options for multiple platform application shall be provided.

PHASE III: Prepare fabrication drawings and fabricate a prototype active MPM antenna for tests. Tests shall be conducted to verify and investigate radiated power, beam forming, power consumption and overall efficiency, and other basic tests as agreed between the contractor and the government. A report shall be prepared by the contractor with all design parameters and test results.

COMMERCIAL POTENTIAL: If MPMs prove to be cost-effective and also efficient in size and weight with better performance than is available in current and projected solid-state devices, there should be potential to use them in commercial radio, television, and radar systems. Present commercial applications are tube-based, the reliability and redundancy of multiple MPMs will be superior to standard high power TWTs or similar large devices.

KEYWORDS: active phased array antennas, Microwave Power Modules, cooling techniques, RF

N98-071 TITLE: Robust Adaptive Target State Estimation for Missile Guidance

OBJECTIVE: Develop and test a more accurate method for target state estimation and thereby improve the terminal homing guidance performance of interceptor missiles. More specifically, develop robust and adaptive new estimation techniques with respect to target maneuvers and seeker errors.

DESCRIPTION: Traditionally, interceptor missiles have employed classical terminal homing guidance laws such as proportional navigation. However, the threats have become faster, more stealthy and more maneuverable, and terminal homing miss distance performance requirements have grown more stringent, such as for "direct-hit" capability. To counter this situation, relatively newer forms of guidance that augment the guidance law with estimated target characteristics have been developed to try to improve terminal homing (miss) performance. However, the accuracy and robustness of the target state estimators to varying target maneuvers and characteristics have been one of the limiting factors of improving the interceptor's terminal performance. This effort will examine techniques to improve the accuracy of the onboard target state estimators, and thereby improve the miss distance performance of homing interceptors.

PHASE I: Formulate and develop a target state estimator that is adaptive and robust to varying target characteristics (such as various target maneuvers and radar cross section). Techniques may include, but are not limited to: robust H2/H-Infinity filtering, the Interacting Multiple Model (IMM) approach; robust, adaptive control/estimation; and/or neural / fuzzy-logic based methods. Demonstrate increased estimator accuracy and robustness compared to a more conventional estimator approach. Demonstrate improved closed-loop terminal homing miss distance performance in either a three degree-of-freedom (3-DOF), 5-DOF or simplified 6-DOF simulation of an interceptor missile against various types of targets and maneuvers, and including anticipated guidance and missile system noises.

PHASE II: Demonstrate improved terminal homing performance of an interceptor missile using the robust, adaptive estimator and guidance approach in a fully detailed, stochastic 6-DOF simulation against various type of targets and maneuvers throughout the performance envelope of the missile. Ensure the computational feasibility of the algorithm for onboard missile computer utilization, and demonstrate operation and performance in an actual missile guidance computer, perhaps utilizing a hardware-in-the-loop simulation.

PHASE III: Transition the technology to an Advanced Technology Demonstration (ATD) missile program, or to a Pre-Planned Product Improvement (P3I) missile program, such as for STANDARD Missile - 2 Block IV P3I or the Evolved SeaSparrow P3I Missile.

COMMERCIAL POTENTIAL: Potential commercial applications of these techniques would benefit the aerospace, transportation, and radar industries. In general, these robust tracking techniques could be applied to various radar (tracking) systems, aircraft and aviation industries, satellites, missiles, unmanned air vehicle systems, and intelligent transportation systems.

KEY WORDS: Robust adaptive target state estimation, missile guidance, guidance filtering, tracking maneuvering targets

N98-072 TITLE: Combat System Software Migration to Open Systems

OBJECTIVE: Identification and development of innovative techniques to implement the migration of combat system application code to next generation processing systems.

The need for open architecture and software standards is only recently recognized as necessary to the development of new technology and applications across various vendor's computing platforms. While standards exist in many areas of computer science, the existing commercial standards inadequately address all the needs of the combat system processing domain.

The techniques must support: 1) Hardware independence - the details of platform-specific features are transparent to the application programmer. Therefore, the underlying computer hardware and operating system may be changed without changing the application code, and 2) Interoperability - applications from other systems and platforms may be easily integrated into the existing system. This requires not only that the application code is portable to the underlying platform, but also that a common computational paradigm is used so that added functions inter-operate with the existing system without major changes.

DESCRIPTION: A Combat System Middleware Standard (CSMS) is required to provide a common computational paradigm and standard interfaces to the underlying platform, and define a software layer composed of standard, non-proprietary interfaces and supporting formats. The CSMS will provide: a means for achieving the goals of efficient development; implementation of new systems; simplified system integration; and portability of both source code and user skills. The purpose of the CSMS will be to promote software portability and reuse by providing a standard application program interface for combat systems. This facilitates hardware independence and interoperability of applications minimizes the need for personnel retraining and adaptation.

PHASE I: Investigate and define how the middleware computational paradigm, data type, constant definitions, and function

prototypes can be implemented in the combat system processing domain. After defining the problem, identify, analyze, and compare alternative techniques

PHASE II: Develop a prototype middleware technology and will demonstrate the ability of the middleware design to meeting the processing requirements (support event reconstruction, message capturing, system timing, etc.) of Navy combat systems.

PHASE III: Integrate the prototype middleware technology into a Navy combat system.

COMMERCIAL POTENTIAL: The generic aspects of the middleware standard approach could be packaged into a CASE tool which will provide software application developers a software development environment which can create multi-platform, real time, enterprise applications.

REFERENCE: J. Ahrens and N. Prywes, "Transition to a Legacy- and Reuse- Based Software Life Cycle", Computer, Vol. 28 No. 10, Oct. 1995, pp. 27-36

KEY WORDS: Middleware; Distributed Processing; Object Oriented; COTS; Hardware Independence; Legacy Systems.

N98-073 TITLE: Low-Cost, Non-Rayon Carbon-"Phenolic" Composites for Rocket Nozzle Applications

OBJECTIVE: Identify alternate constituents, architectures, and/or processing techniques which provide equivalent performance at reduced acquisition cost versus SOTA rayon-based, tape wrapped carbon phenolic (C-Ph) materials.

DESCRIPTION: Tape-wrapped, rayon-based carbon-phenolic (TWCP) materials are used for ablator, insulator, and exit cone components in solid rocket motors (eg., Standard Missile Mk104). The cessation of domestic, aerospace-grade rayon production points to the need for new materials approaches for rocket motor construction. Advanced materials can include alternate fiber(s), fiber architectures, matrix compositions, and/or processing techniques. Equivalent, or improved, ablation/thermal/mechanical performance and domestic sources are required, as is lower acquisition cost.

PHASE I: Review existing materials/processes (M/P) for tape-wrapped component fabrication. Identify M/P variations which potentially reduce fabrication cost. Quantify (via estimation or experimentation) and prioritize cost reduction associated with proposed process variations. Prepare plan to evaluate cost reduction steps in phase II.

PHASE II: Evaluate cost reduction M/P variations identified in phase I. Evaluation may consist of process variation development, sample hardware fabrication, hardware test and evaluation to verify required properties (ablation, thermal, mechanical, etc.), and estimation of cost savings for component(s) or nozzle production.

PHASE III: As needed, additional C-Ph material shall be produced to complete the property data base, and/or nozzle components produced on a pre-production basis to evaluate reproducibility.

COMMERCIAL POTENTIAL: Polymer matrix composites (PMCs), including carbon-phenolic materials, are widely used in commercial (sporting goods) and DoD (aircraft aerosurfaces) applications. The development of lower cost fabrication techniques could be useful for cost reduction in all application areas. Cost reduction of commercial and DoD products could improve market sales of U.S. products in foreign markets.

Reference Data Bases:
1. Solid Propulsion Integrity Program (SPIP).
2. Smart processing of polymer matrix composites.

KEYWORDS: tape-wrapped carbon-phenolic, polymer matrix composites, fabrication techniques, cost reduction, automated processing, smart processing

N98-074 TITLE: Development of Low-Cost X-band T/R Modules with Commercial Off-the-Shelf Components.

OBJECTIVE: Design, Develop, and Demonstrate low cost X-band T/R modules using commercial off-the-components.

DESCRIPTION: The goal of the task is to develop low cost X-band T/R modules with commercial off-the-shelf (COTS) components. The modules should have a peak power near 8W, a duty cycle of 25%, and an operating bandwidth greater than 2.5 GHz. The target cost of the module components and packaging, when purchased in production quantities, is less than $500.

PHASE I: Develop a module design that meets the above requirements. Identify COTS components and determine the estimated production cost of the module components.

PHASE II: Produce five modules specified by the design created in Phase I. Demonstrate transmit power and bandwidth performance.

PHASE III: Work with the government to transition the low cost module design to industry for use with potential Department of Defense or Federal Aviation Administration surveillance radars.

COMMERCIAL POTENTIAL: The module development has potential private sector applications in the satellite and communications industry. Contractors developing X-band components for communications applications will benefit from the transfer of technology.

KEY WORDS: T/R Modules; X-band; Lost cost; COTS

N98-075 TITLE: Low Cost Manufacturing of Lightweight Resin-Matrix Composites

OBJECTIVE: Development of advanced techniques and methods of formulating and fabricating Electroset resin matrix composites that are low cost, lightweight and high modulus.

DESCRIPTION: Lightweight materials such as fiber-reinforced composites offer the ability to fabricate minimum weight structures capable of withstanding high-g loading, and the acoustic and thermal environment of surface to air missiles. Missile components must withstand aerothermal heating, structural vibration and high g loads. Lightweight composite materials are beneficial for such applications.

New Electroset Resins have been discovered that can be electrically cured. The Navy seeks to exploit this unique method of curing to develop low cost, lightweight structural components. Electroset composite manufacture offers the following advantages: a.) fast electrical input heating, b.) highly energy efficient (nearly all of the resistance heating in the curing circuit occurs within the Electroset resin), c.) low capital investment cost. It also offers the means to manufacture and cure composites that are otherwise unproducible and/or unaffordable with thermal autoclave curing methods.

This solicitation seeks innovative approaches to develop the methodologies for manufacture of Electroset resin matrix composites of low cost missile components.

PHASE I: Develop methods of manufacturing resin-matrix composites using Electroset resins and electroset curing. Small scale subcomponents (i.e. sample coupons) shall be fabricated to demonstrate feasibility of the fabrication process and evaluated to provide the initial demonstration of structural integrity.

PHASE II: Develop the manufacturing methods for fabricating full size structural components. Full size structural components shall be designed, fabricated and tested to validate the manufacturing approach and to demonstrate the performance attainable from Electroset resin matrix composites.

PHASE III: Optimize the methods of Phase II and design composite components for performance, cost, and producibility for use in Theatre Air Defense (TAD) missile systems to replace (or, at the very least, to be used in conjunction with) more costly composites in Navy weapon systems.

COMMERCIAL POTENTIAL: Commercial potential exists in a wide range of industries. Low cost Electroset composites will create new multi-million dollar markets for high performance composites in commodity type products where cost is the driver. (Due to their current expense, high performance composites are only used in premium cost products.) Electroset composites can enable greater use of composites in commercial buses, trains, trucks and automobiles thereby realizing cost savings due to significant weight savings and improved fuel efficiency. Electroset curing methods will enable application to an array of economical consumer products from lightweight appliances (power tools) and medical equipment (lightweight wheel chairs) to sports equipment (bicycles, tennis rackets, etc.). Another market exists for composite building components such as corrosion free, long life, lightweight columns and beams.

REFERENCES: U.S. Patent 5,518,664, entitled "Programmable Electroset Processes". The Navy is not asserting any proprietary rights and benefits on this patent in connection with this SBIR topic. This patent will be furnished as government furnished information to successful bidders, and is available from the United States Patent Office.

KEY WORDS: Manufacturing; composites; lightweight; affordable; Electroset; resin-matrix;

N98-076 TITLE: Improvements in Microwave Power Modules

OBJECTIVE: Develop a novel Microwave Power Module (MPM) design which improve the weight, size, efficiency, and/or thermal operating characteristics of state of the art MPM technologies.

DESCRIPTION: Current Antenna designs based on solid state Transmit/Receive (T/R) Modules are heavy and require liquid-cooling due to poor thermal operating characteristics. Improved antenna characteristics may result by incorporating advanced MPM technologies in place of T/R Module designs.

In order to anticipate the next wave of MPM technologies which can provide step improvement in antenna size and weights, we require novel MPM technology to achieve sufficient thermal efficiencies that future antennas can be air-cooled. This will lead to reductions in antenna sizes and/or weights. Additionally, increased efficiencies are sought for MPMs which can be readily associated with related size and weight reductions. Achievement of thermal properties within MPM designs to allow for air-cooling is sought as well.

PHASE I: During this phase, a design for a novel MPM device will be developed. Sufficient aspects of the MPM design will be modeled and analyzed with computational analysis to demonstrate potential performance. Laboratory tests will be conducted to demonstrate thermal characteristics of designs which promise thermal operation improvements.

PHASE II: During this phase a prototype for the design analyzed in phase 1 will be built and tested to demonstrate efficiencies and thermal characteristics.

PHASE III: Military application and commercialization will be pursued in this phase.

COMMERCIAL POTENTIAL: MPMs with step improvements in size and weight as well as better thermal operating characteristics are attractive to many RF devices including commercial radar, communications, traffic safety, measurement sensoring, and security devices. Application to satellite communications is particularly promising due to the projected high demand for smaller and lighter communication payloads.

KEY WORDS: microwave, module, MPM, antenna, thermal

N98-077 TITLE: A Multi-Level Network (MLN) Approach to Theater Battle Management Operations

OBJECTIVE: Design a Multi-Level Network (MLN) to leverage existing sensors and battle management platforms in a stacked and branched open architecture network.

DESCRIPTION: The Multi-Level Network (MLN) is an approach to leverage use of existing sensors and battle management platforms in a stacked and branched network. Existing Command and Control platforms (AEGIS, E2C, AWACS) would serve as gateways between distributive networks, the sensor network, and the tactical information network. These networks would function independently, but share data and commands as needed. The MLN should link the sensor platforms to existing battle management platforms and to the shooters.

PHASE I: Define the Multi-Level Network capabilities, attainable with present sensors and data link, within the various TAMD mission areas. Estimate improved MLN capabilities with the addition of CEC-like data distribution and fusion. As a result of this analysis, develop an open sensor/BMC3 architecture and concept of operations that would be scalable as additional assets deployed to the developing theater.

PHASE II: Develop and demonstrate a prototype implementation of the open MLN. Show how sensor to shooter timeliness can be compressed through the use of multiple sensors netted together via CEC-like data distribution with connectivity to existing command and control platforms and data links to shooters (F/A-18).

PHASE III: Integration of the prototype architecture and technology into the designated sensor platforms and battle management systems.

COMMERCIAL POTENTIAL: Numerous commercial industries rely upon the efficient utilization of available communications band-with. Techniques and technology will be developed under this SBIR that will have broad application in telecommunications, broadcast television, cable TV and corporate inter/intranet

KEY WORDS: Cooperative Engagement Capability (CEC); Joint Maritime Command Information System (JMCIS); Theater Ballistic Missile Defense; TADIL J; BMC4I; Airborne Platforms.

N98-078 TITLE: Compact High Energy Infrared Laser

OBJECTIVE: Develop a compact, high energy, pulsed infrared laser that operates in the 3 - 5 micron and 8 - 12 micron spectral bands.

DESCRIPTION: Develop and prototype compact, low repetition rate (up to 10 Hz), 1 - 10 microsecond pulse-width, greater than 1,000 Joule/pulse lasers in both the 3 - 5 micron (MWIR) and 8 - 12 micron (LWIR) spectral bands to support ongoing development of electro-optical systems. The laser output shall have good atmospheric transmission and the mode quality shall not exceed 2 times diffraction limited.

PHASE I: Investigate the feasibility and demonstrate supporting technologies of a compact, pulsed, high energy 3 - 12 micron laser meeting the energy, wavelength and beam quality requirements. Resolve relevant beam divergence issues. Address design, performance, and operational safety issues of a system to be fabricated in Phase II as well as laser energy scaling issues in achieving the required output energy and repetition rate.

PHASE II: Design, fabricate, test, and deliver a laboratory brassboard, 1,000 Joule/pulse, 1 - 10 microsecond pulse-width, single shot to 10 Hz prf, MWIR and LWIR laser system. Laser head shall fit on a desk top.

PHASE III: Transition technology to develop a highly compact and ruggedized systems for military and commercial applications.

COMMERCIAL POTENTIAL: The wavelength and output energy of this technology is needed for the detection of environmental pollution where the path lengths are greater than 20 km and/or large areas or volumes of atmosphere are monitored.

KEY WORDS: Lasers; mid-wave infrared; long-wave infrared; high energy; pulsed; low repetition rate.

N98-079 TITLE: PCMCIA Card to Collect/Store Vibration/Performance Data for Operating Machinery.

OBJECTIVE: Develop a PCMCIA vibration/performance card compatible with and operational in a Lap Top personal Computer in order to acquire, store, display and screen field-collected data from operating machinery.

DESCRIPTION: The PCMCIA card should facilitate machinery condition monitoring by enabling the acquisition and storage of vibration spectra as well as other condition assessment parameters with a minimum of operator expertise and intervention. Key features of the PCMCIA card must include the following:

- Wide range input preamplifiers with auto range capability for up to six charge-mode and voltage-modeaccelerometer inputs.
- On-board integration and scaling of acceleration signal to vibration velocity.
- Buffered signal monitor output for both pre- and post-integrator (i.e. acceleration and velocity) analog signals.
- Tachometer signal input provisions.
- On-board FFT processing capability with password protected options of 400, 800 or 1600 line resolution and ensemble averaging.
- Capability to compute order-normalized (tracked) spectra based on setting analysis sampling rate proportional to actual machine speed, with or without an external tachometer signal.
- Data validation features including overload indicators, internal self-test hardware, and error-detection software.
- On-board non-volatile storage capacity for at least 2000 FFT spectra and broadband levels.
- Stored data integrity that must be maintained for a period of at least 7 days with no external power connected. In addition, the data must be protected and remain retrievable even with a program "crash".
- Storage of measurement location identifiers and operating condition parameters linked to each spectrum.
- Menu-driven operating software with display of operator prompts.
- User-defined route to direct data acquisition without additional inputs.
- Built-in serial interface and software providing capability for both local and remote communication with host computer.
- Built-in display software for readout of broadband vibration velocity level in VdB units (re 10^-8 m/sec) and display of operator prompts, as well as display of spectrum data in bar graph format.
- Should be designed around some type of standards based open architecture (such as MIMOSA) for interfacing/communicating with many different databases and Condition Based Maintenance (CBM) systems (including AEC, ICAS and commercial systems).

PHASE I: Develop concepts and methods, and a preliminary design for a PCMCIA card that will acquire, store, and to facilitate display and screening of vibration/performance data as noted above.

PHASE II: Develop and fabricate a prototype PCMCIA card conforming to the Phase I preliminary design and including signal conditioning, FFT analysis/order tracking, screen displays, control software, card connections, and procedures as necessary to demonstrate the PCMCIA card performance and production potential to the Navy community.

PHASE III: Develop a production version of an operational PCMCIA vibration/performance card. Furnish a production-quality data collector card for testing and evaluation.

COMMERCIAL POTENTIAL: Vibration data collectors are becoming a standard in Navy and private industry CBM programs for

the evaluation of machinery condition. Private industries with operating machinery such as power plants, and cruise ships would benefit from a PCMCIA vibration/performance card because in a large number of these programs, a separate data collector that interfaces with a PC/Laptop must be purchased and maintained. This card will fit into and communicate with any PC or Laptop computer and eliminate the need for this high cost separate specialized instrument. Therefore, developing a PCMCIA vibration/performance card will benefit private industry as well as the Navy.

KEY WORDS: vibration, performance, data, collector, maintenance, PCMCIA

N98-080 TITLE: Hover-Craft (LCAC) Vehicle Dynamics

OBJECTIVE: To develop a fully validated aerodynamics model for use in the Navy's Landing Craft Air Cushion (LCAC) Full Mission Trainer.

DESCRIPTION: A robust aerodynamics model does not currently exist for the LCAC due to the absence of validated flight test data for the vehicle. This deficiency is currently limiting the fidelity and training effectiveness of the LCAC Full Mission Trainer (FMT). Complex visual simulation of dynamic open ocean and littoral features is now achievable, however training of LCAC pilots in a fully dynamic marine synthetic environment is not possible without a high fidelity LCAC aerodynamics model to support it. The purpose of this research is to gather the complete test data by taking measurements with the operational craft; and to perform experiments with the new model on the LCAC FMT.

PHASE I: Determine the flight data which must be collected, and the tests and logistics required in order to obtain the necessary data. Identify a methodology for integrating the developed model with the LCAC FMT in order to perform experiments.

PHASE II: Conduct the flight tests, analyze the data, develop the math model, code the model in software, validate the model, and integrate the new model with the existing LCAC FMT.

PHASE III: The validated models, software, and expertise developed under this contract will become the basis for commercial products to be sold as design tools to numerous manufactures of commercial and military (including foreign military) hovercraft, and for training simulations.

COMMERCIAL POTENTIAL: Hovercraft are now considered more cost-effective than conventional craft for several commercially important applications, e.g., shuttle services for transportation and tourism, transferring cargo in harbors and rivers, search and rescue operations, and for breaking up ice in navigable waterways. Hovercraft are also becoming increasingly popular for recreational use. There is a need for high fidelity simulation models, both for design and for validation of performance and safety characteristics of commercial hovercraft before they are approved for use.

KEY WORDS: LCAC; hover-craft; aerodynamics; vehicle dynamics; simulation.

N98-081 TITLE: Variable Virtual Combat Mock-up (VVCM)

OBJECTIVE: Develop innovative concepts and techniques for utilizing virtual reality Operator Machine Interfaces (OMI) for Combat System training.

DESCRIPTION: Recent developments in Navy shipboard training programs such as Battle Force Tactical Trainer (BFTT) have revolutionized the manner in which we train our crews in combat systems employment. BFTT utilizes advanced distributed modeling and simulation techniques in concert with a cognitive learning model to optimize team performance. There are occasions when shipboard training is not practical (Overhauls, Availabilities, New Construction) and crew proficiency training is still required to be conducted ashore. Current shore based solutions are cumbersome and costly. What is needed is a virtual CIC/CDC mock-up for team training purposes that is variable to each specific ship/class configuration. Shore based training scenarios could be run utilizing an S14A13 Tactical Advanced Simulated warfare Integrated Trainer (TASWIT) data base or other compatible, emulation-type, training software. Sailors should be given the appearance of being physically located in their own CIC/CDC, at their own operator position during the course of a given scenario.

PHASE I: Research existing trainer architectures, Identify likely candidates, develop Training concept of operations and architecture for interactive utilization of selected trainers in a virtual OMI environment.

PHASE II: Develop a prototype virtual CIC/CDC Trainer demonstrating the openness of the chosen architecture, the ability to replicate multiple ship/configurations and conduct effective training.

PHASE III: Build upon the architecture developed and demonstrated in Phase I & II to develop and produce virtual

CIC/CDC Trainers for New ship classes and apply the architecture to existing ships as a backfit program.

COMMERCIAL POTENTIAL: Many industries rely upon trainers to hone the skills of individuals operating within a team. Full scale mock ups of the operator stations can be extremely expensive to maintain and update to new configurations. Commercial power plants, Air Traffic Control, large manufacturing plants, ect. can benefit from this technology by establishing virtual operator stations for training.

KEY WORDS: Team Training; distributed simulation; virtual reality; open systems; reusable software; trainers

N98-082 TITLE: Reconfigurable Computing

OBJECTIVE: To develop a reconfigurable computing system using programmable gate arrays

DESCRIPTION: An Application Specific Integrated Circuit (ASIC) is found in all Commercial Off-The-Shelf (COTS) processors (i.e. Intel Pentium, HP PA-RISC, DEC Alpha, Sun Sparc). Each custom designed ASIC has gate densities that are typically 10 times that of programmable gate arrays. However, as gate densities continue to increase, it becomes feasible to apply programmable gate arrays in various computing applications now served with custom ASICs.

For example, programmable gate arrays have been successfully used to emulate the Reduced Instruction Set Computer (RISC) architecture typically found in a Digital Signal Processor (DSP). The use of a programmable gate array vice a specific DSP eliminates the hardware limitations of the DSP, and thus, readily supports enhancements of a design by emulating new DSP features in the same hardware. The capability to reconfigure the hardware logic to execute new software functions offers many benefits to the system designer and can provide a significant reduction in the cost of engineering changes.

The use of programmable gate arrays supports the reconfiguration of the hardware logic without the constraint of a single-purpose processor design. This feature permits the use of common hardware for multiple purposes and could eliminate the need for custom ASICs. Thus, the hardware for a reconfigurable computing system would be generic and only programmed when needed for a specific purpose. The application of reconfigurable computing could dramatically reduce or eliminate the Navy's reliance on custom ASICs.

PHASE I: Develop a detailed architecture for a reconfigurable computing system using commercially available, programmable gate arrays.

PHASE II: Design, fabricate, test and demonstrate a prototype reconfigurable computing system by emulating two or more COTS processors and executing the same computer program compiled for operation on each of the target COTS processors demonstrated.

PHASE III: Fabricate and test production configurations of the reconfigurable computing system.

COMMERCIAL POTENTIAL: The use of a reconfigurable computing system has significant benefit in reducing obsolescence and in reducing the transition cost associated with changing from one COTS processor to another COTS processor. The commercial applications for reconfigurable computing include the potential replacement of most low-end COTS processors with programmable gate arrays. The potential for reconfigurable computing may also support new developments in commercial markets where "intelligent" processing is required, such as intelligent appliances, home security and the gaming industry.

KEY WORDS: Reconfigurable; Processor; Computing; Programmable; Gate; Arrays

N98-083 TITLE: Non-intrusive, non-mounting, non-contacting hand held Vibration Data collector, storage and analysis system for Operating Machinery

OBJECTIVE: To develop a non-intrusive, non-mounting, non-contacting system to collect, store and analyze vibration data from operating machinery.

DESCRIPTION: The field of vibration measurement can be significantly enhanced by the development of non-intrusive, non-mounting, non-contacting system (possibly utilizing laser, infrared or fiber optic technology) that retrieves, stores and analyzes vibration data for operating machinery. The sensor should facilitate machinery condition monitoring by enabling the acquisition and storage of vibration spectra from 10 - 10kHz, and amplitude range from 80 to 140 VdB re 10^-8 m/sec.amplitude range from 80 to 140 VdB re 10^-8 m/sec.

PHASE I: Show the feasibility of developing a non-intrusive, non-mounting, non-contacting system to collect, store and analyze vibration data from operating machinery. A detailed description of the method (such as laser, infrared, fiber optic or other

technologies), discussion of the theoretical basis for operation, and your planned approach showing how this system will operate .

PHASE II: Focus on providing actual schematic diagrams, detailed drawings, technical and physical specifications for the method and the approach planned to be used. Demoinstrate a breadboard model.

PHASE III: Initiate manufacturing of model demonstrated in Phase II.

COMMERCIAL POTENTIAL: Acquiring vibration data for the evaluation of machinery condition is a standard in Navy and private industry CBM programs. Private industries with operating machinery such as power plants, and cruise ships would benefit from a non-intrusive, non-mounting, non-contacting vibration sensor because in a large number of these programs, a time consuming process is required for each machine to install an average of five vibration pads to accurately define the motion. A non-intrusive, non-mounting, non-contacting vibration sensor would reduce the amount of time needed to acquire vibration data. Currently, the Navy and private industry hardwire many sensor locations to acquire vibration data. This system would be able to greatly reduce this time. A person would be able to go to any machine, without installing any pads, point the sensor, and acquire vibration data. This system will also eliminate all of the possible errors normally associated with mounting fixtures, e.g. epoxy, grease, proper torque, machine bearing temperatures, etc.. Therefore, developing such a system will benefit private industry as well as the Navy.

KEY WORDS: vibration, hand-held, data, collector, maintenance, non-intrusive

N98-084 TITLE: Development of a Registration Mine Capability

OBJECTIVE: To improve the burial models (and their tactical utilization) and to validate them at sea, a capability is required which will allow the monitoring of mine burial (upon impact or upon longer term burial due to scour, etc.) and which will measure the environmental forcing functions responsible for the burial (e.g., currents).

DESCRIPTION: In expeditionary warfare, the ability to predict the likelihood of buried mines is critical to developing tactical options as well as MCM tactical decision making. Activities within NATO Mine Burial Specialist Team (MBST) and The Technical Cooperation Program (TTCP), as well as recent field trials, have made it clear that existing models are inadequate and/or have not been validated via sea tests. To improve the burial models (and their tactical utilization) and to validate them at sea, a capability is required which will allow the monitoring of mine burial (upon impact or upon longer term burial due to scour, etc.) and which will measure the environmental forcing functions responsible for the burial (e.g., currents). Outside of rudimentary capabilities by the Germans and Dutch, which measure degree of burial by optical means, this capability does not exist. Therefore, the objective of this effort is to develop a capability to measure mine burial over time and to concomitantly measure the environmental forces responsible for the burial. In addition, this capability, called a registration mine, will allow MCM operational testing and training for hunting partially buried mines. This capability must be flexible enough for use with virtually any mine shape and suitable for measuring all relevant environmental parameters and forces acting on the mine. This will negate the requirement for a specially built registration mine for each mine shape of interest (cylindrical, bomb, truncated cone, etc.). There are essentially two primary military uses for this capability. Firstly, mine burial can be monitored over time, and the degree of burial can be related to the environmental forces responsible for the burial. This information will allow verification of mine burial prediction models and can lead to significant improvements in mine burial prediction capabilities. Secondly, once the mine is partially buried, the sensor package would determine the exact amount of burial and mine orientation. This information is critical for training and in the evaluation of the capabilities of our MCM forces to hunt partially buried mines.

The burial/sensor capability to be designed and built under this topic would be attached either conformally to or internally within the mine shape. In either case, the sensor package must have minimal impact on the environmental forces driving mine burial, must be able to function in any orientation and attitude, and must preserve the gravity, weight, and target strength of an operationally configured mine. The effort requires three phases:

PHASE I: The contractor would be expected to develop and finalize an optimum design of the sensor package. A significant design consideration is that the mine shape must fall from a ship, through the water column, and impact the sea floor. The design to be provided will require attachment method, candidate sensors, and data storage, display, and retrieval. The design effort will require some hardware research for selecting materials and electronics as well as verifying concepts.Projected Sensor Package Requirements:

- Configuration suitable for installation on/in two mine shapes cylinder and truncated cone. Built in growth potential with additional analog data channels for future sensors
- Selectable process control parameters (start/end data, sample interval, etc.)
- Power for 3 month operations with sampling every hour
- Memory and data not lost with power loss
- Data retrievable using typical spread sheet program on a lap top computer

- Lifetime of 15 years with life cycle costs minimized
- Depth to 200 meters
- Nonproprietary software to allow for future development of the package.
- Data capabilities required; time series measurements over a three month period; a single sensor type (e.g., acoustic) for % burial, water currents, sediment transport, acoustic energy; mine attitude on the bottom; mine orientation; a seismic sensor for local forces (burial due to shakedown/liquefaction); water depth

System Description: The sensor package, as a minimum, should consist of the sensor package module, the data acquisition and data storage module, a battery power module, and any associated equipment needed for deployment in and/or attachment to the two mine shapes. Data retrieval, display, and analysis will typically be done on ship, using a commercially available spreadsheet type program, following an in water deployment of the package. Modules can be integrated or separated; however, the requirement mandates that size and shape of the sensor package be as small as is possible so that its impact on the environmental conditions is minimized. A typical operation with the package would include deployment by falling through the water column onto or into a sea floor varying from soft mud to hard sand, followed by up to three months (i.e., several tidal cycles) on/in the sea floor. During that period, the package would be exposed to a variety of mine burial processes in water depths as shallow as 10 feet and as deep as 200 feet. Wave action, and associated forces, are likely to be significant.

PHASE II: The contractor will build two (2) system prototypes for test. Equipment supplied by the contractor will include: sensor package, power, and data storage, retrieval, and display systems. A field test of the sensor package will be required using two target shapes, a cylinder and a truncated cone, for verifying versatility of the package. Mine shapes will be government supplied.

PHASE III: For final acceptance, the contractor will participate in two full up field demonstrations of the registration mine sensor package. Each field test will require 5 to 7 day sea tests using a commercial research vessel or an operational navy ship.

COMMERCIAL POTENTIAL: The sensor system has both foreign military and commercial sale potential. Interest in this type of capability has been shown by the United Kingdom (Defence Research Agency) and Australian (Defence Science & Technology Organization) for use by their naval forces in training and assessment of mine burial models. Additionally, the package could be used commercially to determine the suitability of the sea floor for burial of objects such as moorings, platforms, and pipelines that are placed on the sea floor. It would therefore be used in any application that needs to know the suitability of the sea floor for supporting objects/structures. The package can also be used to provide environmental monitoring of baseline conditions and changes within an area of interest. Thus, it is suitable for use in a wide variety of applications in environmental survey (i.e., environmental impact or site selection) and monitoring.

KEY WORDS: Mine Burial; Mine Burial Modeling; Environmental Measurements; Mine Burial Sensor; Mine Countermeasures; MCM; Environmental Parameters

N98-085 TITLE: Virtual Integrated Engineering Data Extraction Environment

OBJECTIVE: To develop an internet data extraction capability by extracting engineering information from a disparate and geographically dispersed heterogeneous set of ship engineering databases.

DESCRIPTION: Current ship engineering efforts for new ship construction and inservice alterations require a large and varied quantity of multi-source data from organizational distinctive and geographically separated databases or "data warehouses". The numerous heterogenous databases and their data views are used to create an integrated ship data environment that supports and includes: operational concept formulation, modeling, analysis and validation; design and interface performance specification; contractual statements of requirements generation; logistics and management resource planning and scheduling. These data sources stretch across unclassified and classified databases implemented on various computing hardware and database management systems to implement: (JCF), Fleet Installation Planning and Programming System (FMPFIS), Shipboard Warfighting Improvement Program (WIPX), Surface Ship Combat System Master Plan (SSCSMP), (SEMCIP), (CSCADES). The demand for data from those databases relies on manual search, query, extraction, aggregation and post-retrieval storage techniques which is both inefficient and costly. An automated, integrated ship engineering data environment is needed. In this environment, the user will create a particular engineering data schema or "view" accessing and retrieving data from the various database sites and their associated data warehouses. The user can browse the databases to create a particular data schema. This enables the user to define, evaluate and assess newly created data relations and to validate hypotheses and establish "new" relationships. The effort's by-product enables one to perform data mining" from the engineering data "cyber space", represented by the existent ship engineering data warehouses, to create an integrated virtual data representation of the ship.

PHASE I: Perform analysis of the "data warehouse" environment for existent ship engineering data bases, determine their interrelationships and interdependencies, and establish feasibility of linkages and data extraction.

PHASE II: Develop prototype "data mining" extraction system exploiting the internet to browse and extract engineering

information from multi-source data environments to create "new" virtual data views for use in formulating and validating ship operation concept, ship performance and interface specification, contractual requirements generation, support requirements, and managing resources and scheduling.

PHASE III: Produce user friendly "data mining" extraction system and tools tailored for use in each commercial business sector.

COMMERCIAL POTENTIAL: The development of the sought capability for "data mining" and "virtual" database generation has significant promise for commercial use where integrated engineering data environments would have application in designing, developing and implementing large or complex systems, such as: commercial aircraft, vehicles, buildings, manufacturing plants and communication systems. Commercial engineering data and models from diverse fields, such as architectural engineering; mechanical engineering; aero-nautical engineering; environmental engineering; and ocean engineering—created by various business sectors produced by different commercial entities—are being brought together to better understand the systems by discovering the interdependencies between system elements. For example, an aircraft producer/designer/integrator, such as Boeing Aircraft, relies upon its first, second and third tier suppliers/vendors to provide it the systems, sub-systems and components need for the aircraft. Those suppliers/vendors possess unique and distributed databases that capture various information aspects about their products. Through a virtual database integration capability, Boeing is able to iteratively model, study and examine a prospective aircraft's design, performance, logistics support and costs associated with its constituent elements from several aircraft engineering design and business perspectives in performing an engineering and production trade analysis.

REFERENCES: Common Object Request Broker Architecture (CORBA), Distributed Common Object Model (DCOM), JAVA Database Connectivity (JDBC), Open Object Database Connectivity (ODBC).

KEYWORDS: Internet, data mining, data warehousing, database, object model, programming.

N98-086 TITLE: Cleaners for Wastewater Ultrafiltration Membranes

OBJECTIVE: Development of a non-polluting cleaning technology for removal of clogging buildups and/or microbial fouling from ultrafiltration membranes used in treatment of non-oily wastewater (graywater/blackwater) on surface ships.

DESCRIPTION: New technologies for treatment of non-oily liquid wastes produce by Navy surface ships are being developed in Navy laboratories. These technologies are designed for removal of microorganisms, particles and organic material from the waste stream in order to meet regulatory standards for discharge of treated water into the ocean. Liquid wastes that will be treated with these new systems include graywater (shower, laundry and galley wastes) and mixtures of graywater and blackwater (toilet wastes). During operation of the treatment systems, ultrafiltration membranes gradually foul and become partially clogged with waste buildup or microbial biofilms, leading to reduced performance and, eventually, to failures in meeting regulatory standards. This effort would lead to development of innovative, safe, non-polluting cleaning technologies (for continuous or periodic cleaning) targeted specifically toward the kinds of fouling found in or on ultrafiltration membranes processing shipboard graywater/blackwater wastes.

PHASE I: Develop a design for and demonstrate feasibility of a cleaning technology appropriate for removal of fouling and clogs from shipboard waste treatment filter membranes. The design should consider the type(s) of fouling encountered, compatibility with membrane and other treatment system materials, and requirement for non-interference with treatment system performance or effluent quality.

PHASE II: Develop and test a cleaning system, based on the technology used in Phase I, that can be incorporated into a bioreactor/membrane ultrafiltration wastewater treatment system for use on ships. The cleaning system should be evaluated for efficacy, safety, ease of use, and compatibility with the overall wastewater treatment system.

PHASE III: Manufacture, delivery and evaluation of membrane cleaning systems for installation on ships equipped with ultrafiltration membrane reactor systems.

COMMERCIAL POTENTIAL: Ultrafiltration membranes are used increasingly in treating a variety of liquid waste streams in industry, government, and public/municipal operations-both on land and abroad commercial and other non-military vessels. Fouling of membranes is a difficult problem in many of these applications. The technology developed here could be applied to any membrane ultrafiltration system.

REFERENCES: "Graywater Characterization," Mary C. Whelan, DTRC Report TM-28-89-01 (1989).

KEYWORDS: Cleaning, ultrafiltration, fouling, enzymes, wastewater, membranes

N98-087 TITLE: Modulated Scattering Technique (MST) Field Probe Array System (FPAS) for Rapid Near-Field Measurements of Antennas and Composite Walls

OBJECTIVE: Design and develop an innovative transportable Field Probe Array System (FPAS) based on the Modulated Scattering Technique (MST) to make fast, accurate Near-Field(NF) measurements of a) Navy microwave antenna radiation and b) composite wall transmission and reflection coefficients. The MST/FPAS should also provide the Near-Field/Far-Field transformation software for computing antenna patterns based on the Spherical Angular Function (SAF) technique for use in such shipboard antenna analysis codes as GMULT, GLOSS, and GCUPL, and the Near-Field diagnostic imaging codes for imaging the interior of topside composite walls.

DESCRIPTION: SAF computer codes for predicting shipboard antenna performances are continuing to be developed. Future ships will increasingly utilize antennas that are either enclosed or embedded in composite structures. It will be necessary to have accurate SAF data for current and future antennas that must also be able to rapidly assess the composite wall electromagnetic performances over surface areas that are both physically and electrically large during the entire operational life cycle. NF measurements of the antennas and composite walls are required in order to derive accurate SAFs and to accurately determine composite wall reflection/transmission performances at in-band and out-of band frequencies. Unfortunately, NF test systems that employ mechanical scanning in two dimensions can require many hours to scan the antennas and composite wall areas of interest for this application, and they are typically not suited for shipboard use.

Recent efforts concerning rapid NF measurement technology based on MST probe arrays appear to be promising for development of economical transportable NF measurement systems that can be used either in dedicated indoor test chambers or onboard ship. The requisite NF data can be acquired in a few seconds or minutes by electronically scanning along the probe array length and mechanically scanning in the orthogonal direction. MST probe array systems use low frequency multiplexing to address the probe elements, thereby avoiding the expense and reliability problems associated with microwave switches employed in conventional phased array systems technology. Research conducted under controlled research laboratory conditions show that reductions of 95 percent, or more in the NF measurement time for antenna testing can be achieved by using MST probe array systems as compared to conventional mechanical scanning in two dimensions. However, further innovation and development is necessary in order to derive cost-effective broadband, dual-polarized, transportable MST probe array systems for shipboard antenna and composite wall applications under realistic operating conditions.

PHASE I: Perform a preliminary design study to assess and demonstrate the technical feasibility of the proposed NF measurement technique. Design the transportable MST/FPAS for rapid NF testing in the 0.9 GHz to 4.0 GHz frequency band. Design the system to measure two orthogonal polarization states over the designated frequency band. Perform analyses and numerical simulations 1) to determine probe array spacing and number of probe elements, 2) to assess candidate probe array feed systems, 3) to determine the achievable probe element VSWR, insertion losses, backscatter, and cross-polarization characteristics, and 4) assess the performance envelopes of the MST probe array system for NF testing of antennas and composite walls. Describe and demonstrate the NF transformation and NF diagnostic testing software that will be used to process the measured NF data, and identify any needed improvements that will be implemented in Phase II to meet accuracy specifications.

PHASE II: Perform the detailed design and development of the MST/FPAS based on the results of Phase I and additional advanced engineering design and development work specific to the implementation of an operational transportable prototype. The prototype shall operate dual-polarized in the 0.9 GHz to 4.0 GHz frequency band. Demonstrate the MST/FPAS prototype hardware and software for rapid NF measurements of two selected Navy microwave antennas and composite walls.

PHASE III: Implement and demonstrate advanced MST/FPAS's for rapid NF measurement of antennas and composite walls in 1) the 4.0 GHz to 12 GHz frequency range and 2) the 12 GHz to 24 GHz frequency range.

COMMERCIAL POTENTIAL: Potential commercial applications of this technology include near-field testing of telecommunication antennas and airport surveillance radars, near-field radome testing for commercial aircraft, near-field EMC testing, non-destructive testing of multilayer composite industrial materials, paper and wood products, control of commercial microwave drying processes, imaging of buried objects such as concrete reinforcing bars, pipes, cables, and drugs/weapons caches, and microwave hydrology.

REFERENCES:
1. B.J.Cown, J.P.Estrada, Ph. Garreau, D.Picard, and J. CH. Bolomey, "Efficient Near-Field Measurements of Antennas, Radomes, and Scattering Targets via the Modulated Scattering Technique", 1996 AMTA Symposium Proceedings, Seattle, WA, Sept 30 - Oct 3, 1996
2. B. J. Cown and J. P. Estrada "MST Portable Near-Field Antenna Measurement System Study", Final Technical Report, GTRI and GEMTECH, U.S. Army Contract No. DAAB07-88-K-A020, December, 1995.
3. B.J. Cown, et. al.,"Advanced MST Automated Electromagnetic Field Probe for Anechoic Chamber Testing, Final Technical Report, SATIMO Project SIA-9602, Contract F04611-96-C-0060, March 27, 1997.
4. Barry J. Cown,et.al., "Fast Anechoic Chamber Diagnostic Testing via Modulated Scattering Arrays and the MUSIC Imaging

Code", 1997 IEEE/URSI Meeting Digest, Montreal, Canada, July 13-18, 1997.

KEY WORDS: MST probe arrays, Near-field antennas, Composite

N98-088 TITLE: Co-Infusion of Multiple Resin Systems Through the Thickness for Composites Structures with Enhanced Fire Performance

OBJECTIVE: Develop a low cost fabrication process capable of co-infiltrating a composite fiber preform with a two distinct resin systems such as or vinyl ester and phenolic using a resin transfer molding technique to achieve a low cost fire tolerant composite structure in a single manufacturing step.

DESCRIPTION: The constituent elements of a composite material are typically chosen to achieve specific mechanical attributes. The fibers are chosen for their stiffness or strength, i.e. mechanical properties, and the resin is chosen for its environmental requirement, cost, or processability. To provide appropriate fire tolerant composite structures, secondary manufacturing steps are normally required where additional layers of material are added to the composite surface which provide enhanced fire performance. A process which would manufacture the total system with both matrix materials in a single step process would save both money and time and would produce a more survivable system. This effort would use resin systems which are of interest by the Navy to develop a processing technique which could produce low cost hybrid matrix composites with two distinct resin systems through the thicknesses.

PHASE I: Develop and demonstrate experimentally a method for simultaneously infiltrating a dry fiber preform with two distinct resin systems such as vinylester and phenolic having distinct resin fronts through the thickness The fabrication method should be one that can be scaled up to large parts, i.e. areal dimensions of 10 ft. x 10 ft minimum, and which is low cost such as a some variant of the VARTM process.

PHASE II: Identify primary structural application and design and manufacture a large scale component (½ scale) which requires the dual resin system such as a composite deck house with integral fire barrier. Perform mechanical integrity tests and fire performance studies on fabricated structure.

PHASE III: Manufacture large scale hull component. Develop complete data base on material system including low temperature, elevated temperature and moisture conditioned properties.

COMMERCIAL POTENTIAL: This type of system could be utilized in numerous industrial applications where low cost fire tolerant composite systems are required. Such applications include bridge structures rehabilitation, cruise ships, internal aircraft structures (cabin/bulkhead) and submersible applications.

KEY WORDS: co-infusion, fire, damping, VARTM, low cost

N98-089 TITLE: Development of a Low Cost Process to Provide Improved Carbon Fiber-Vinyl Ester Adhesion

OBJECTIVE: Develop a process/material modification for carbon fiber/ vinyl ester composite materials which will provide enhanced fiber-matrix adhesion using a low cost, room temperature manufacturing process such as vacuum assisted resin transfer for high performance composite structures. This level of adhesion should be comparable to carbon-epoxy. One test method to measure the affectiveness of an improved adhesion is through a transverse tensile test, where these strengths should approach that of the resin material. These values should be for both as processed and saturated conditions. Current values are anywhere from approximately 50% for as processed to 25% for saturated conditions of the desired transverse tensile strength.

DESCRIPTION: Carbon fiber composite materials are typically high cost materials because of the basic material costs, as well as the manufacturing costs. One way to reduce the cost of carbon fiber composite structures would be to utilize low cost material forms, such as heavy weight fabrics, with a room temperature curing resin material such as vinyl ester. This combination of materials could then be used in a low cost fabrication method such as VARTM (vacuum assisted resin transfer molding process). This would provide the Navy with a low cost, high performance composite material which could be used for a primary structural material with high stiffness. Current vinyl ester/carbon combinations have not demonstrated adequate mechanical properties due to their poor fiber/matrix adhesion.

PHASE I: Develop and demonstrate experimentally a method for improving the fiber/matrix adhesion for carbon fiber broadgood materials with vinyl ester resin .

PHASE II: Identify primary structural application and design and manufacture a large scale component (1/2 scale). Develop material property data base required for design. Test the structural integrity of the part through laboratory/in-service testing.

PHASE III: Manufacture large scale hull component. Develop complete data base on material system including low temperature, elevated temperature and moisture conditioned properties.

COMMERCIAL POTENTIAL: This type of system could be utilized in numerous industrial applications where low cost high stiffness materials are needed. Such applications include bridge structures rehabilitation, high performance pleasure craft/racing yachts and other recreational equipment, and numerous aircraft structures.

KEYWORDS: interface, carbon fiber, vinyl ester, VARTM, low cost

N98-090 TITLE: Automated Mechanism for Transfer of Unclassified Information Residing in Secret Environments into Unclassified Environments Using Intermediate, Multi-Level Databases

OBJECTIVE: Provide greater capacity channels for transfer of otherwise Unclassified or Sensitive But Unclassified (SBU) engineering information originating in Secret environments to Unclassified or SBU environments for the purpose of translating and creating new and appropriate databases as needed.

DESCRIPTION: Modern engineering practices involve a wide range of data and data generating processes which reside in environments of different security classifications. In particular, some information developed by simulations in Secret environments must eventually feed back to engineering tasks that occur in Unclassified environments in order to incorporate certain types of design modifications. Although the information to be transferred would otherwise be Unclassified or SBU, the Secret environment within which the information has originated makes transfer of the information problematic. Existing solutions rely on low through put techniques such as e-mail based guard technology which also tend to depend on direct operator control to ensure security. This is a very manpower intensive and costly approach. What is needed is a higher capacity, secure technique which can provide a specific solution to the engineering design data feedback problem. There are two primary categories of threats that contribute to the complexity of general Hi to Low security environment transfers. First, the message content may camouflage classified information. For example, a 24 bit graphic image might carry an encoded message in portions of its data that do not visibly affect the image. Second, the timing of message traffic, especially from the Hi to Low side can be used to deduce information about the Hi security side. In addition to these two factors, general solutions are made more complex by the need to provide for simultaneous provision of data at multiple security levels.

PHASE I: This SBIR focuses specifically on the Secret to Unclassified / SBU transfer problem - retention of data in a Classified environment is unnecessary. It is expected that this stipulation will simplify the categorization and resolution of the involved threats. The first objective of Phase I is develop a taxonomy of those threats. A general characterization of the Hi to Low message content threat is that the outgoing data can act as a covert carrier for additional information. The second objective of Phase I is to examine and identify options which are available to reduce or eliminate additional message capacity. Message based methods for data transfer inherently involve the timing threat factor due to the general need for synchronous or asynchronous responses to confirm data transfer. Camouflaging of such confirmations may be more complex than needed to support the specific functionality needed here. This SBIR focuses on the use of non-message based methods in order to minimize the timing threat. In particular, this research is to examine the feasibility of using a multi-level database with interfaces to both Unclassified and Secret environments as a means of "exposing" data in ways that reduce the involved threats. The third goal of Phase I is to identify and document the means by which such databases may be used to counter-act the timing threat factors. The fourth objective of Phase I is to evaluate current multi-level databases with respect to suitability, and to develop a specification, based on the findings of the first three objectives, for the programming of such a database to achieve the overall goal. The final objective of Phase I is to demonstrate feasibility with respect to existing multi-level database components.

PHASE II: The design developed during Phase I would be implemented within the context of a standalone workstation - the EMA / WS. This may involve verification of new multi-level features with respect to the DoD Trusted Computer System Evaluation Criteria (TCSEC) and will involve working with a designated approving authority to achieve approval of the solution.

PHASE III: The validated approach and components developed during Phase II will be extended to other Navy engineering environments, and a commercial version will be developed for private industry. The expected result would be an overall increase in the productivity of engineering activities involving Hi to Low data transfers, thereby decreasing design development time and reducing costs.

COMMERCIAL POTENTIAL: The proposed technology would benefit all efforts which involve transfer of low sensitivity information from Secret to Unclassified environments. It is also expected that the developed techniques may offer an alternate approach to security for private industry concerned with controlled exposure of public or less sensitive data which is integrated with and stored with sensitive data such as the banking and credit reporting industry.

KEY WORDS: Trusted multi-level database; Guard technology; Message capacity;

N98-091 TITLE: Quieting Inflow to Enclosed Impellers and/or Open Field Propellers for Acoustic Silencing

OBJECTIVE: The objective is to obtain quieter propulsors by utilizing annular flow conditioning to obtain quieter and more efficient propulsors for US Navy vessels.

DESCRIPTION: Turbulent flow into enclosed impellers/open field propellers generates propulsor inefficiencies which results in increased noise levels. Reducing the turbulent with annular devices prior to the propulsor will result in a more efficient and quieter impeller/propeller.

PHASE I: Phase I will investigate annular inflow control and the potential hydroacoustic and efficiency benefits. Model acoustic testing to confirm the potential of this silencing technology will be conducted.

PHASE II: Phase II will be the construction of larger scale models for acoustic and hydrodynamic testing and validation in test tanks/flow facilities (water tunnels). Full documentation in report format clearly demonstrating acoustic noise reductions and hydrodynamic effects in terms of efficiency changes.

PHASE III: The completion of Phase II will have clearly demonstrated acoustic improvements and the hydrodynamic effects of annular flow control techniques for transition to Phase III. During Phase III, the offeror shall develop a large scale flow control device for installation on a large scale model and/or small ship. This device will be tested in accordance with current Navy acoustic programs. The Navy will provide access to such a vehicle/ship for this project.

COMMERCIAL POTENTIAL: The commercial application of propulsor silencing is applicable to the commercial fishing industry, and the sport boat industry. The envisioned device will reduce acoustic noise in the water, which is disruptive to marine life. The utilization of quiet propulsors will yield more accurate research studies on marine life.

KEYWORDS: Acoustics; propellers; impellers; silencing; quiet; annular flow control

N98-092 TITLE: Shipboard Airborne Noise Control Design and Diagnostic Tool

OBJECTIVE: To effectively incorporate airborne noise and vibration control in the overall ship design and construction process to improve airborne noise and vibration environment on all vessels while reducing the associated adverse impacts on space, weight, maintainability of systems and cost.

DESCRIPTION: The current shipboard airborne noise control design guide is outdated and does not accurately handle non-conventional hull types or design features and can only be used effectively by acoustics engineers. The objective is to develop a computerized noise prediction and analysis tool that will utilize the latest technology and methods to accurately handle various airborne noise control issues. This tool will run on PCs and will be used by any non-acoustics engineers to perform various design trade-off studies, as well as by acoustics engineers for more in-depth analysis.

PHASE I: Develop an overall scheme and methods for the task. Identify all the resources (expertise in shipboard acoustics and computer programming) to be used for this task. Develop a detailed logic scheme for the computer programs and select prediction algorithms. Establish input/output methods and formats.

PHASE II: Compose algorithms for various elements of the prediction procedures and complete the overall computer program that meets the above description. Test this program on a ship with measured noise deficiencies to test the programs accuracy and then to use the program to recommend appropriate corrective actions for the measured noise deficiencies. Develop a user's manual.

PHASE III: Use the program on a new ship program for noise predictions, then make modifications as necessary after verifying the accuracy of the predicted results against actual measurements. Develop interface for various databases to be used with the program.

COMMERCIAL POTENTIAL: This program can be used as an airborne noise control design tool by any commercial shipbuilding industry. The program is to be a comprehensive acoustic modeling tool that will include the latest noise prediction techniques and methods that can handle various hull types and sizes of ships so that any shipbuilding industry can greatly benefit from the capability of this tool in controlling the shipboard airborne noise. Not only the program will use the latest acoustic technology but also to utilize the computer programming techniques to build in the logic necessary to make the program user friendly so it can be used by people without acoustics background. The program is to be menu-driven and is to request the user all of the design information necessary to run the program.

REFERENCE: Society of Naval Architects and Marine Engineers (SNAME), Technical Research Bulletin 3-37, Design Guide for Shipboard Airborne Noise Control, Prepared by Fischer, R.W., Burroughs, C.B., Nelson, D.L., January 1991.

KEY WORDS: SNAME design guide update; airborne noise; shipboard habitability

N98-093 TITLE: Biofouling and Biocorrosion Monitor

OBJECTIVE: Develop a real-time sensor technology to detect microbial biofouling in seawater piping and cooling systems.

DESCRIPTION: The performance of shipboard piping and cooling systems is adversely affected by the formation of biofilms. Microbial fouling can lead to degradation of heat exchanger performance, promotion of macrofouling, and deterioration and failure of metals susceptible to microbiologically influenced corrosion (MIC). Chlorination commonly is used to mitigate biofouling and MIC in these systems. Chlorine demand from piping and cooling systems produces rapid decay of the free, available chlorine that is added, and underchlorination may result in inadequate biological control. Overchlorination, on the other hand, can produce excessive corrosion of pipe and tubing materials and also can lead to undesirable environmental impacts. On-line biofilm/biofouling sensors or monitoring technologies are sought that can provide information on whether biofouling control methods are performing adequately throughout a seawater piping/cooling system. Ultimately, use of such a sensor for automatic control optimization of chlorine or other biocide application is desired.

PHASE I: Design and demonstrate feasibility of a sensor technology that can monitor performance of biofouling control methods in seawater piping systems. The sensor should detect biological fouling specifically (as opposed to abiotic fouling) and have the potential for online, real-time application. Microbiological tests must demonstrate that sensor output does indeed correlate with extent of biofouling. Contractor will deliver a report that includes design details and data that support feasibility for continued development.

PHASE II: Develop the sensor system for use as a real-time, on-line monitor of biocide effectiveness and test it in seawater piping test loops and/or in a shipboard simulation. Demonstrate its specificity for biological fouling and correlation with extent of fouling. Deliver a prototype sensor system and demonstrate its effectiveness when used with Navy materials and piping/heat exchanger designs. Develop and test a design for integrating the sensors into shipboard piping and cooling systems for automatic control of biocide application. Determine potential savings in terms of cost, biocide reduction, maintenance and labor.

PHASE III: With commercial partners, prepare, demonstrate and deliver a fully integrated, automated sensor/biocide control system for use in military and civilian piping and cooling systems. Install a system on a Navy vessel and evaluate its reliability, effectiveness, ease of use, compliance with environmental regulations, safety and cost savings.

COMMERCIAL POTENTIAL: An on-line biofouling monitoring technology would be useful to all users of cooling water who experience problems in system performance resulting from bio-film-induced degradation of thermal exchange or deterioration of materials due to MIC. This technology would also facilitate environmental compliance by preventing over-or-under application of biocides to cooling water.

REFERENCES:

(1) W.G. Characklis, B.J. Little, M.S. McGaughey, ÒBiofilms and their effect on local chemistry,Ó Microbial Corrosion: 1988 Workshop Proceedings, Electric Power Research Institute Report ER-6345, 1988.

(2) E.D. Thomas, K.E. Lucas, M.H. Peterson, D.K. Christianson, ÒEffects of chlorination on marine materials,Ó CORROSION/88, Paper No. 402.

(3) G. Ventura, E. Traverso, A. Mollica, ÒEffect of NaClO biocide additions in natural seawater on stainless steel corrosion resistance,Ó Corrosion 45(4):319.

(4) B. Wallen, S. Henrikson, ÒEffect of chlorination on stainless steels in seawater,Ó CORROSION/88, Paper No. 403.

KEYWORDS: Biofouling, biofilm, chlorination, microbiologically influenced corrosion, sensors, biodeterioration

N98-094 TITLE: Affordable High Performance Reinforced Polyurethane Shock and Vibration Mounts

OBJECTIVE: Develop a low cost multiple performance generic elastomeric machinery mount system which has varying static and dynamic vibration properties to provide vibration isolation over a wide operating load range. These mounts should be capable of meeting performance specifications for several mounts/load ranges as given in for example MIL-M-17185 (General Mount Spec.), MIL-M-17191 (P-Type Mounts), MIL-M 17508 (E-type Mounts), MIL-M-19379 (M-type Mounts), MIL-M-19863 (5B5000 Mounts) and MIL-M-21649 (5M10000 Mounts).

DESCRIPTION : Isolation mounts are used extensively on Navy ships to 1) reduce vibration noise from the hull to sensitive acoustic interrogation systems, and 2) to minimize the transmission of vibration energy of machinery to the ship hull. The Navy currently uses over 60 different types of mounts to provide vibration isolation for loads ranging from 0.5 lbs to 10,000 lbs. This program would seek to develop a generic mount configuration which could be utilized for a large range of load isolation requirements. Successful development of a single multiperformance mount will yield numerous benefits including reduction of inventoried items, reduction in costs associated with fewer parts fabricated, and standardization of installation and maintenance procedures.

PHASE I: Develop a system configuration which through analytical or experimental means exhibits potential for providing isolation for a significant range of loads. Identify configurational requirements that must be considered in developing an elastomeric multi-element system. Develop/Identify potential low cost fabrication methods for manufacturing the systems.

PHASE II: Transition analytical/experimental findings into prototype mount concepts for a family of mounts. Design, fabricate and characterize the static and dynamic properties of the prototype mount concepts. Fabricate associated hardware and conduct shock and vibration testing to assess performance. These shock and vibration requirements should be established with NAVSEA support. Provide prototype mounts for seatrials. Provide similar mounts for evaluation in industrial applications where vibration isolation from rotating equipment is required, particularly in harsh and corrosive environments.

PHASE III: Develop preliminary specifications for performance and mechanical requirements along with mount drawings for NAVSEA evaluation. Transition mounts to the fleet through installation of mounts for numerous fleet applications. Provide industry with range of mounts for vibration isolation of machinery components.

COMMERCIAL POTENTIAL: This type of system could be utilized in numerous industrial applications where noise and vibration are of concern. The potential use is very wide, which includes rotating and reciprocating equipment, isolation of precision equipment, as well as civil applications such as earthquake management.

REFERENCES: Rivera, Rimi O., "Non-metallic 15P150A Machinery Mounts", CARDIVNSWC-SSM-64-94-14, Aug 1994, 99p.

KEY WORDS: Mounts, reinforced polyurethane, vibration isolation, shock isolation, corrosion resistance

N98-095 TITLE: Red Phosphorous Powder Manufacturing Process

OBJECTIVE: The objective of this topic is to develop a means to produce red phosphorous powder suitable for incorporation into polymeric materials as a fire retardant.

DESCRIPTION: Hydrated metal oxides are commonly used as a fire retardant in some polymeric materials. Red phosphorous can provide superior fire suppression performance over other commonly available materials, but there currently are no production processes which can provide red phosphorous powder with the required attributes. This project concentrates on the development of a production process for making red phosphorous powder that with the appropriate properties for inclusion into polymer systems as a fire retardant.

PHASE I: Identify at least two new and innovative manufacturing processes for processing red phosphorous into a powder suitable for incorporation into polymer compounds. Concentrate investigations on processes that can produce grain sizes less than 5 microns and that inherently minimize the risk of explosion or fire. Compare the risks and benefits of the manufacturing processing identified and recommend one process for further development and validation. Develop a validation plan detailing the proposed manufacturing process, the initial process validation approaches, proposed process controls and equipment required.

PHASE II: Validate the capability of the process identified in Phase I to produce red phosphorous material with the appropriate grain sizes. Build a prototype red phosphorous processing station and develop detailed operations, quality control and safety procedures. Demonstrate the operation of the processing stations and provide sample quantities of processed red phosphorous to the government for evaluation.

PHASE III: Begin full scale production of the red phosphorous powder and begin supplying material to commercial polymer parts manufacturers.

COMMERCIAL POTENTIAL: The largest application of this product is in the commercial polymer materials and components market. The fire retardancy of polymer materials using this fire retardant may be an order of magnitude greater than that possible using currently available materials.

KEY WORDS: Material Processing; Red Phosphorous; Fire; Fire Retardant

N98-096 TITLE: Non-skid Surface Coatings for Navy Fleet Applications

OBJECTIVE: Develop non-skid coating systems with superior abrasion resistance, decreased life cycle cost, improved chemical and corrosion resistance, and resistance to cracking and spallation.

DESCRIPTION: Currently available non-skid coating systems (non-skid materials) used in the fleet (aircraft carriers, bridges, ordnance, etc.) are short lived and inadequate in performance. An example is their use on aircraft carrier decks where resistance to chemicals and corrosion is poor, and cracking and spallation due to aircraft takeoffs and landings routinely occurs. The innovation goal of this effort is development of an entirely new non-skid coating system with improved life cycle performance and significantly increased mechanical, physical, and chemical properties.

PHASE I: Identify and/or formulate new non-skid coating systems. Modify as needed for optimum performance and perform bench scale tests to demonstrate their potential as coating systems which exceed the system requirement.

PHASE II: Establish new performance criteria for non-skid coatings. Select the more promising candidates from Phase I and conduct laboratory scale tests on selected substrates to compile a database on the critical physical, mechanical, and chemical properties of candidate non-skid systems. Based on the performance data developed in Phase II, prepare a preliminary modified MIL-PRF-24667A specification.

PHASE III: Under program office sponsorship conduct large scale tests on fleet systems and hardware to demonstrate that the performance goals identified in Phase 11 can meet field requirements. Commercial applications will also be identified.

COMMERCIAL POTENTIAL: Improved non-skid coatings systems can be applied to the commercial shipping industry, to improve overland transportation safety (non-skid roadways), and to recreational applications (swimming pool decks, tennis courts, etc.). Technology transfer to commercial applications will be encouraged during Phase III.

REFERENCES:

1. Neman, C., Shirley J., et al., "Penetration of a Chemical Agent Simulant into a Marine Non-skid Surface Coating"; Naval Research Laboratory, Washington, DC; May 15, 1987.
2. Kerrige, J., Zirkel, J., "Evaluation of USN Support Equipment for Use as Decontamination Vehicles; Naval Air Engineering Center, Lakehurst, NJ; December 31, 1990.

KEYWORDS: Coatings, non-skid materials, ship decks, cleaning, flight decks, decontamination

N98-097 TITLE: Fiber Optic Link Simulator

OBJECTIVE: The objective of this topic is to develop a fiber optic link simulation tools with a graphical user interface that allows standard fiber optic link analysis (per EIA/TIA-626 for multimode fiber systems) and which provides for optional link design analysis for multimode and single mode fiber systems with bit rates up to 10 gigabits per second.

DESCRIPTION: Fiber optic link analysis is currently a labor intensive effort that is implemented using custom built software or spreadsheets. Most link integrators and many link designers are not familiar with fiber optic communication link theory or how to calculate the effect of using different components on the performance of the link. A fiber optic link simulation tool is needed that will allow a fiber optic link designer to design candidate fiber optic links and then simulate the loss, distortion, jitter and noise characteristics of those links. The simulator should minimally provide amplitude, noise, jitter, and distortion simulation for the fiber optic link. The simulator should also be able to display the transmitted signal at user selected points within the link, the eye pattern at user selected points within the link, the optical source output power versus current curve, and the receiver bit error ratio versus input power curve (for the defined link distortion).

PHASE I: Develop the simulator architecture description. Identify a basic set of components and those parameters that will be in each component's library file. Identify the analytical model(s) that will be used for each component. Develop a list of critical link parameters for the standard analysis and the more detailed analysis options.

PHASE II: Develop a simulator specification detailing the user interface attributes and the information flow and the internal program module interface attributes and information flow. Develop and validate (theoretically or experimentally) models for each components and models for the entire link. Develop and deliver a complete analysis program to the Navy.

PHASE III: Provide the software program to Navy and commercial designers and integrators.

COMMERCIAL POTENTIAL: The largest application of this product is in the commercial manufacture of local area network equipment. This application would be a invaluable to the government and commercial local are network design communities.

REFERENCES: EIA/TIA-626 "Fiber Optic Link Transmission Design."

KEYWORDS: Fiber Optics; Fiber Optic Link Design.

N98-098 TITLE: Injection Molded Ceramic Ferrules for Fiber Optic Connectors

OBJECTIVE: The objective of this topic is to develop an injection molding technique and production capability for ceramic ferrules for single mode fiber optic connector applications.

DESCRIPTION: Ceramic ferrules are used in over 95% of the single mode fiber optic connectors sold in the world. Current production methods are relatively expensive ($2 to $10 per ferrule depending upon quantity) and involve the production of ferrule blanks which are shaped to the final dimensions using numerous grinding and polishing operations. As an alternative method, injection molding techniques could be used to produce these parts without requiring many of the grinding and polishing operations. Typical injection molding processes are not sufficient due to problems in controlling the net shape of the molded part to the degree necessary (<0.5 micrometer tolerances on ferrule outer and inner diameters). An improved injection molding process is required which minimizes shrinkage during the curing of the green material and which minimizes the formation of voids during the injection process.

PHASE I: Investigate and develop an optimized injection molding process for ceramic ferrules for single mode fiber optic connectors that will result in ferrule prices less than $1 per ferrule for relatively small quantities (10,000 pieces). Develop a manufacturing plan detailing the manufacturing process (and the process controls) and equipment required for mass production of the ferrules. Develop a working relationship with a major U.S. fiber optic connector manufacturer.

PHASE II: Build a prototype manufacturing line for the production of ceramic ferrules for single mode fiber optic connectors and a prototype test and measurement station for the measurement of critical ferrule parameters. Produce prototype ferrule samples and characterize the ferrules, investigating the effects of different ferrule formulations (binders, powders, etc) and different process control limits on the final ferrule quality. Determine if the molded ferrules will require final grinding and polishing to meet the dimensional tolerances required. Implement any final grinding or polishing operations into the prototype manufacturing line and produce and characterize manufacturing representative ferrule samples.

PHASE III: Begin full scale production of the ferrules and begin supplying ferrules to U.S. commercial fiber optic connector manufacturers.

COMMERCIAL POTENTIAL: The largest application of this product isin the commercial fiber optic connector market. Almost all fiberoptic ferrules used in the fiber optic connector industry are produced overseas. These ferrules are costly and can be limited in availability at times.

KEY WORDS: fiber optics, ferrules, connectors, single mode.

N98-099 TITLE: Dynamic Firing Zone for Weapon Systems

OBJECTIVE: Develop a Method of Providing a Real-time Dynamic Firing Zone Compatible with all Naval Weapon Systems.

DESCRIPTION: Firing zones for all U.S. Navy's weapon systems are static zones which are created from a CAD model and manually updated over a ship's lifecycle. The current highly manpower-intensive and costly method of updating requires routine ship check for physical verification of the topside configuration around the weapon system using bore sighting equipment. Then the CAD model must be updated to reflect the current topside configuration. This method of firing zone development and update can only be as accurate and current as the last physical verification; the typical firing zone update period is between two to four years. Another distinct disadvantage of the current method is that due to its static nature, this method is incapable of considering the movement of other major topside equipment such as other weapon systems, aircraft and helicopter operations, cranes, king posts and boat davits.

The main obstacle in providing a more-user friendly and less manpower-intensive, weapon system firing zone is in finding a method to automatically determine the actual physical environment around a weapon system without the need for constant physical verification through human interventions. One potential method may be to use high-resolution digital video technology to gather the initial two-dimensional bore sight image then to used a highly sophisticated computer vision algorithms to automatically decipher a three-dimensional image from the original two-dimensional video image. Another potential method may be to use very accurate, high speed sensors to acquire a three-dimensional composite picture of the physical surrounding around a weapon system.

PHASE I: Develop the conceptual approach and the detailed system design for a user-friendly and less manpower-intensive

weapon system firing zone. Design the system, show feasibility, and report the progress, results and design as required.

PHASE II: Construct a prototype system capable of receiving digital image from the bore of a MK 45 5"/54 gun system. Test the accuracy with different ship motion characteristic associated with several different sea state conditions. In addition, test the high level image processing accuracy and time of the system with the introduction of several moving objects such as rotating crane, helicopters and missiles into the defined firing zone.

PHASE III: Modify design for full compatibility with all other naval weapon systems such as Rolling-Airframe-Missile (RAM) system, Nato SeaSparrow System (NSSM), and Close-In-Weapon System (CIWS). Optimize speed of the IPPR as well as the accuracy.

COMMERCIAL POTENTIAL: The main commercial applicability will be in the fields where high level image processing techniques are required such as automation of map making. Currently the maps required for geological purposes require level of accuracy to within 1 foot; this level of object discrimination can not be achieved using current image processing techniques and these video and film images have to be manually dissected for map making. The medical application is another field which requires extremely high level of accuracy; this is mainly due to the obvious life and death consequences involved when utilizing x-ray and MRI image processing techniques. High speed IPPR coupled with acceptable degree of accuracy would also greatly aid in factory automaton and/or robotics. Another commercial application area requiring advancement in IPPR would be in naval, airborne and automotive navigation including collision avoidance systems. Without the capability to accurately and automatically identify any moving or static object around a vessel, an automatic navigational system cannot be developed.

REFERENCES:
1. NAVSEAINST 9700.1A
2. NAVSEA SW 270-AA-ORD-010

KEYWORDS: Firing zone; computer vision; machine vision; bore sighting; artificial intelligence.

N98-100 TITLE: Self-Routing in Photonic Packet Switching

OBJECTIVE: To develop a self-routing in photonic packet switching for the phased array radar (PAA).

DESCRIPTION: A photonic system that can quickly compare packet header and router information is highly desirable for the next generation of the phased array radar and optical communications. Presently, the OC-192 of the frame relay of the ATM network is capable of 10 Gbits/sec data rate. In addition to a higher data rate, the Phased Array Antenna (PAA) requires 2D array switching and processing to the antenna elements. Therefore, an all-optical method of packet header comparison with minimal speed bottleneck to allow more than orders of magnitude faster throughput (such as 100 Gbits/sec) is very critical to both optical communication and military applications.

PHASE I: Develop innovative concepts, and provide proof of concept by demonstrating photonic/hybrid method(s) capable of at least 100 Gbits/sec throughput. Provide a photonic/hybrid demonstration device for proof of concept (small scale).

PHASE II: Develop, fabricate, and test a full scale (at least 16 x 16) fast self-routing photonic packet switching system. Provide design disclosure package and test plans, and report test results.

PHASE III: Transition to phased array radar and fiber optic communication system

COMMERCIAL POTENTIAL: Highly diverse communication system applications, including the Internet and Automatic Teller Machine (ATM) Network. Most of current ATM network and the Internet is based on electronic switching/routing that limits the speed significantly, typically to Gbits/sec. A photonic system that can quickly compare packet header and router information is highly desirable for both these applications.

REFERENCES: The fifth annual ARPA symposium on Photonic Systems for Antenna Applications, 1995; Photonics in Switching, vol. 1, AP, 1993

KEY WORDS: All-optical, Packet Switching; ATM; PAA; Fiber; Optical Communication

N98-101 TITLE: Corrosion Prevention and Control for Out Board Submarine System

OBJECTIVE: Develop a composite material based on research and test, to be used in conjunction, either with an existing system or as a stand alone solution, to extend the service life of a launch tube from 18 months to 10 years.

DESCRIPTION: The Navy currently uses a zinc phosphated 1026 steel on a system that is inherently subject to corrosion over time during the mission profile. A cost effective material change is desired to increase the service life of the system from 18 months to a target of 10 years. The final product shall meet the following requirements:
- The composite material must meet the requirements of the Clean Water Act.
- Submarine system certification requirements: (1) explosive shock (2) shipboard vibration (3) ordnance testing
- The composite material shall not increase the weight of the system by more than 1 pound. The candidate material must be capable of meeting the dimensions of a launch tube (Navy drawing 53711-6658880).
- The unit cost of a launch tube that incorporates the material must meet affordability constraints with a goal of cost increase not to exceed 50% of the existing cost.
- The launch tube must survive the launch of a MK 77 MOD 0 Gas Generator without deformation. The launch tube shall not be water soluble and shall be capable of creating water tight seals for the entire service life.

PHASE I: Explore material properties and identify a composite material alternative to the existing system. A thorough Environmental survey shall be provided for the material candidate. Activation energy data for the material shall be provided so that accelerated life test (ALT) models can be developed. A manufacturing process outline is required. The outline shall demonstrate the feasibility of implementing the material into full scale production.

PHASE II: Using the data from phase I along with Navy input, sample coupons shall be fabricated and ALT to simulate 10 equivalent service life years of the system on a Trident Class Submarine. The sample coupons shall consist of the material identified in phase I. ALT data shall quantify, in terms of a dimensioned profile, the average effect of corrosion on a specific section of the sample coupon. A strength prediction on the profiled section shall be made using Finite Element Analysis, given a specific impulse load. Full scale prototype launch tubes shall be fabricated using the candidate material. The prototype launch tubes shall be used for explosive shock, vibration, ordnance launch, and sea trial testing.

PHASE III: An acceptable candidate material, once successfully demonstrated, shall be implemented into full scale production via transition to PMS415.

COMMERCIAL POTENTIAL: The material technology obtained will have widespread use in any commercial sea application. Target markets would include the oil, transportation, and recreation industry where there is a need for high performance and service life extension of components on sea rigs and vessels.

REFERENCES:
1. Handbook of Corrosion Data, ASM International, OH, 1990, Library of Congress ISBN-87170-361-0
2. Corrosion Resistance Tables, Metals, Nonmetals, Coatings, Mortars, Plastics, Elastomers, Linings, and Fabrics, Third Edition, Marcel Decker Inc, NY, 1991, Library of Congress ISBN: 0-8247-8372-7 and ISBN: 0-8247-8373-5.
3. Handbook of Plastics, Elastomers, and Composites, Third Edition, McGraw Hill, U.S.,1996, Library of Congress ISBN 0-07-026693-X

KEYWORDS: composite, environmental survey, accelerated life test, dimensional profile, finite element analysis

N98-102 TITLE: Monopropellant Fuels

OBJECTIVE: Develop an improved liquid monopropellant for torpedoes and other unmanned underwater vehicles.

DESCRIPTION: The Navy currently uses monopropellants in both lightweight and heavyweight torpedoes. The monopropellants contain a homogeneous blend of both fuel and oxidizer to reduce complexity and the need to carry along oxygen. Current monopropellants are harsh on torpedo propulsion hardware and produce a costly waste stream. The goal of this effort is an improved monopropellant that meets or exceeds current performance capabilities, meets Navy defined safety criteria and results in no harmful/toxic exhaust products.

The Navy's primary monopropellant, know as OTTO Fuel II, uses a nitrated alcohol as the energetic consituent. The propellant's decomposition yields approximately 1,100 BTUs per pound (11,275 BTUs per gallon) at a flame temperature of approximately 2300ûF. New propellants must be backward compatible in systems that currently use OTTO Fuel II. Energy content, flame temperature, and material compatitibilty are the more significant attributes that must be retained. The propellant is described in *Technical Manual for OTTO FUEL II.* Any new propellant must pass insensitive munitions testing as described in *MIL-STD-2105, Hazard Assessment Tests for Non-nuclear Munitions.* Pertinent excerpts of both documents can be made available.

PHASE I: Establish the feasibility of candidate propellants that react/decompose at stoichiometric conditions with no harmful/toxic exhaust products.

PHASE II: Synthesize small quantities of candidate propellants and conduct small and full scale testing to demonstrate the reaction of the candidate propellants through safety and combustion testing.

PHASE III: Design processes to produce the selected fuel on a large scale basis and transition the selected fuel into the Navy lightweight and heavyweight torpedo systems.

COMMERCIAL POTENTIAL: The development of this fuel should have direct application to use in automobile air bags, very high altitude aircraft, space shuttle APU and for emergency power in oxygen limited space applications (e.g., underground mines, submarines, etc.) and any other gas generator applications.

KEY WORDS: liquid monopropellants; liquid fuels; liquid oxidizers; torpedo propellants; gun propellants; torpedo propulsion

N98-103 TITLE: Universal Acoustic Sensors for Acoustic Sonar Arrays

OBJECTIVE: Develop an affordable universal acoustic sensor for acoustic towed line arrays and/or conformal hull mounted sonar arrays.

DESCRIPTION: The goal of this effort is to decrease the cost of acoustic towed line arrays and conformal arrays. Decreasing the number of unique component types for acoustic arrays will allow volume production of sensors. The universal acoustic sensor should be omnidirectional and cover the primary hull mounted transmit frequency and passive low frequency ranges. Universal means that a single sensor design would cover several octaves of frequency. An alternative would be to have a family of sensors fabricated from the same component set which would allow a major sensor (and array) cost reduction. The sensor may incorporate programmable telemetry that would be fabricated as an integral part of the sensor. For example, the sensor could allow summation of its individual mid-frequency acoustic elements to form area averaging lower frequency acoustic sensors. The low frequency sensors could be formed by remotely selecting 2, 4, 8 etc. multiples of the single element sensors to achieve nested towed array apertures. The sensor may be one time programmable at the acoustic channel level and may include the associated telemetry. The sensor shall allow operation below sea state 0 and have a large dynamic range to prevent acoustic signal overload. The developmental sensor(s) should have a diameter of 1/2 inch or less. It is desirable to design the sensor to interface to the NUWC developed Monolithic Analog Signal Conditioner (MASC) Integrated Circuit. The input noise level for the MASC is approximately -160 dB re uPA/Hz. The MASC input capacitance is about 20 picofarad. It is desirable to have a sensor with a specific gravity close 1. The sensor, when installed in a towed array, will be reeled on a 30" diameter drum. The sensor should have a survival pressure of at least 2500 psi and operate over a pressure range from 0 to 1000 psi. It should operate over all ocean temperatures. A production sensor cost of under $50 each is desired when procured in quantities of 5000 sensors. Additional sensor cost may be incurred if the cost increase is offset by a reduction in telemetry component costs. The sensor should be a key enabling technology for affordable submarine and surface ship towed arrays such as TB-29A, SURTASS, and MFTA.

PHASE I: Develop concept definition, architecture, specification, description, and program plan for a prototype universal acoustic sensor. Develop a preliminary sensor design that will used to demonstrate the universal sensor and why it will be affordable.

PHASE II: Develop and Fabricate Sensor Prototypes and for acoustic test demonstration compatibility with existing Navy towed array assets such as TB-29A and TARS acoustic test array modules for acoustic testing is desirable. Demonstration of affordable cost basis is also essential. The NAVY may construct and test a towed array test module using the sensors.

PHASE III: Transition to towed and conformal array programs. A demonstration array for a Navy towed array or conformal array may be developed and constructed using preproduction quantities of these sensors.

COMMERCIAL POTENTIAL: Acoustic arrays used in oceanographic, hydrographic, and oil exploration applications. Potential markets for spinoffs from the approach include telecommunications, BISDN, and related developments.

KEY WORDS: Sensors; sonar; towed acoustic arrays; conformal acoustic arrays; BISDN communication links

N98-104 TITLE: Embedded Intelligent Tutoring Systems

OBJECTIVE: Develop embedded intelligent tutoring software within the Tactical Control Program (TCP)

DESCRIPTION: The Tactical Control Program (TCP) develops run time applications for transition to combat systems on submarines and surface ships. Reduced staffing initiatives and the movement of training away from shore-based facilities mandate the use of embedded training facilities in shipboard environments. Intelligent tutoring systems can provide extremely powerful learning experiences, and can simultaneously address skill and knowledge training, real-time performance assessment, and just-in-time

training. Innovative intelligent tutoring requires that the tutoring adapt to the skill level of the operator being trained and to the state of the whole system which the operator is part of--in this case, combat system tactical readiness. Future combat system automation requires a vehicle which monitors system/operator performance levels and provides real-time training requirements at the system level and coaching at the operator level.

PHASE I. Identify the metrics and approach for readiness/training/skill assessment in real time and at the end of a watch and provide a proof of concept for an embedded intelligent tutor.

PHASE II . Implement the embedding strategy described in Phase I. Using TCP architecture/conventions and JMCIS/DII standards, develop embedded training assessment metrics and tutoring strategy/methods. For selected TCP products, build prototype training products.

PHASE III The prototype products, if acceptable, should transition directly into TCP. After that, the TCP product family has many other modules / segments which will need complementary training components.

COMMERCIAL POTENTIAL: Any software product either for the government or for the commercial sector needs directions and training. "HELP" functionality built into most software is usually focused on directions for use of that software. "TRAINING" buttons on software packages would be the natural extension of this. With real software training built into software packages, greater acceptance and fully use can be achieved. The entire "shrink-wrapped" software industry could benefit if embedded training architecture and module building were made uniform through a embedded training system which would ease training authoring and facilitate software use.

KEY WORDS: Embedded training, tutoring systems, decision aids, TCP

N98-105 TITLE: Tunable Vibration Absorber for Small, Underwater Vehicles

OBJECTIVE: Provide vibration control technology capable of reducing acoustic radiation from small, underwater vehicles by adaptive-passive noise control techniques.

DESCRIPTION: Hull radiated noise is a strong component of the overall noise spectrum of high speed undersea vehicles. Reducing this noise will make these vehicles difficult to detect. In the low frequency range, the broadband quality of this noise is controlled by longitudinal modes of the hull that efficiently radiate acoustic energy. Adaptive-passive noise control techniques have the potential to effectively reduce the amplitude of vehicle vibration modes that are efficient radiators of acoustic energy. Dynamic absorbers can be used to counteract the vibration amplitudes associated with these modes, but the absorber must adapt to changes in vibration sources and the vehicle's responses to these sources. Additionally, care must be taken to insure that, during the adaptation process, the absorber does not settle onto non-radiating modes of the structure. These non-radiating modes can have frequencies that are very close to the natural frequencies associated with the radiating modes. The technique must be robust so as to adapt to changes in source frequency and to prevent the system from adapting to control acoustically inefficient modes of the hull.

PHASE I: Design and develop a tunable vibration absorber apparatus and sensor package capable of reducing low-frequency torpedo radiated noise due to low-frequency longitudinal modes of the shell. The design shall fit within the confines of a 21" diameter shell.

PHASE II: Fabricate and perform laboratory based, in-water testing of the prototype apparatus designed during phase I. The Navy will provide an appropriately configured torpedo shell for the demonstration experiments and will support the required in-water testing of the prototype unit. Up to three prototype units will be provided to the Navy. The contractor shall support post-test analysis.

PHASE III: Following a successful phase II demonstration, production design and integration of the tunable absorber unit into current and future fleet systems will commence. The entire system will be shock and vibration test qualified. A TBD number of production units shall be fabricated and delivered to the Navy.

COMMERCIAL POTENTIAL: Tunable vibration absorbers will have a commercial value to products requiring vibration reduction under the condition of varying source frequency. Most examples involve variable speed rotating machinery including aerospace and automotive applications.

REFERENCES:
1. M. A. Franchek, M. W. Ryan, and R. J. Bernhard, "Adaptive passive vibration control," Journal of Sound and Vibration (1995) 189(5) 565-585.
2. F. Fahy, Sound and Structural Vibration, Academic Press, London, 1995

KEY WORDS: Vibration absorbers; radiated noise; adaptive noise control; torpedoes; active control; underwater vehicles

N98-106 TITLE: Acoustic Interference Rejection

OBJECTIVE: Develop the capability to detect and adaptively reject own ship's acoustic interference during tracking and localization of wideband acoustic signals in the presence of countermeasures and own ship radiated noise.

DESCRIPTION: Develop signal processing algorithms that will provide acoustic interference look through in shallow water operations. These algorithms shall allow existing acoustic intercept and broadband passive detectors to exploit their intended targets without detecting own ship's deployed countermeasures or own ship radiated noise.

PHASE I: Develop, describe and implement automated "Acoustic Interference Rejection" algorithms for application to an acoustic intercept system (both active and passive). Achieve proof-of-concept within the constraints of platform resources and operational environments.

PHASE II: Complete and test a full prototype implementation of the Phase I algorithms for at sea demonstration and evaluation. Demonstrate feasibility via a rapid prototype system within an existing Navy acoustic intercept system.

PHASE III: Fabricate and deliver additional systems for test and integration into existing US Navy platforms.

COMMERCIAL POTENTIAL: Undersea surveying, mining, oil exploration, and marine biological research

KEY WORDS: interference rejection; acoustic intercept; countermeasures; passive detection; broadband; wideband signals

N98-107 TITLE: SC 21 Smart Product Model (SPM)

OBJECTIVE: To develop and demonstrate through distributed simulation an initial federation of models for a surface warship. This initial federation will be part of the envisioned total ship Smart Product Model (SPM) for SC 21.

DESCRIPTION: The Program Office plans to build a Smart Product Model of the ship. This SBIR will develop a federation of models that will become a part of the total SPM. The SPM is envisioned as a tool for the evaluation of ship concepts throughout the life cycle of the program and to facilitate implementation of Cost As an Independent Variable (CAIV). The SPM must be able to evaluate proposed concepts in the areas of ship and system performance, warfare assessment, cost, manufacturing, test and evaluation, training, future upgrades, and operations. It will also be utilized to evaluate prototype and production equipment and computer programs as part of the T&E program throughout the ship's life cycle. The SPM will include system models for shore, space, air, undersea and other surface based segments.

Definition: A Product Model (PM) is defined as a combination of geometric and non-geometric engineering data which describes the physical and logical configuration of the ship, including elements of the ship's information architecture and combat systems. A Smart Product Model is defined as a Product Model that has component and system level physical and operational behaviors and environmental data incorporated.

PHASE I: Develop proposed method to demonstrate the SPM concept for a surface warship such as SC 21. This will include development of model selection criteria and process by which to build an initial federation of models.

PHASE II: Build the federation proposed in Phase I and demonstrate its utility in a distributed simulation.

PHASE III: The federation of models that has been built and demonstrated in Phase II will be incorporated into the SC 21 Smart Product Model during Phase III. This technology will also be transitioned to other ship acquisition programs such as CVX.

COMMERCIAL POTENTIAL: A successful development of an SC 21 SPM will make it possible for industry to propose use of their systems/equipment on surface warships and evaluate the performance of their systems in the environment in which the ship will operate without the need for expensive operational demonstrations. Private sector application/dual-use of SPM technology will be the development of the capability in the Defense industry (shipbuilders and Defense contractors) to be better able to diversify and compete in commercial markets on other than Defense products through the use of this technology that will reduce product cost and time to field. In this way, we will be helping to maintain the Defense Industrial Base.

REFERENCES:
1. http://www.dmso.mil
2. http://www.itsi.disa.mil
3. http://sc21.crane.navy.mil
4. http://www.acq-ref.navy.mil
5. http://sbdhost.parl.com

KEY WORDS: Federation; Smart Product Model; Simulation; High Level Architecture (HLA); Simulation Based Design (SBD); Simulation Based Acquisition (SBA)

N98-108 TITLE: Grabber for Ordnance Handling Robot

OBJECTIVE: Develop the end effector for a robot to handle ordnance items such as gun projectiles

DESCRIPTION: Automation of weapon handling is a high priority for the Navy, driven by the need to reduce ship manning and eliminate fatigue as a cause of accidents. For ordnance items that are currently moved by hand, such as gun projectiles, propelling charges, chaff cartridges, and sonobuoys, a grasping robot is the preferred approach. (Specialized packaging that interfaces with a handling system would add substantially to the cost of the ordnance items and consume space.) This topic seeks development of a "hand" for an ordnance handling robot that combines dexterous, adaptable manipulation, fast operating speed, great strength and the ability to maintain repeatable accuracy of a couple of centimeters while being subject to acceleration rates of up to 30 meters/sec2. The hand must grasp items such as a five-inch projectile (100 lb, 5 inches in diameter, 62 inches long) or 155 mm projectile (200 lbs, 155 mm diameter, 73 inches long). It should be strong enough to maintain control of the projectile as the robot moves it quickly during shock and ship motion.

PHASE I: Develop a design for a robot end effector to handle five-inch projectiles and propelling charges. Optimize the design for strength, stability, long operation life, versatility (able to handle a variety of projectile shapes and sizes), and safety (the robot must work in a magazine). The effector should be able to grab a round from a honeycomb storage tube (accessing the round from the end), from an unstructured stack on a pallet, and from an opened shipping container.

PHASE II: Fabricate the end effector and demonstrate its ability to handle rounds in conditions similar to a shipboard automated magazine. These conditions include shipboard shock, vibration, and ship motion loads, as well as the movement of the handling robot, which will accelerate the end effector at up to 30 meters/sec2

PHASE III: Incorporate the end effector into an automated magazine as part of the Next Generation Naval Gun and Vertical Guns for Advanced Ships (VGAS) program. Develop the end effector for other weapon-handling functions such as Mk 36 decoy loader launching or loading sonobuoys onto aircraft.

COMMERCIAL POTENTIAL: Such end effectors represent a significant increase in robotic capability. Current robots use grabbing actions for small components (a few pounds) but rely on specially made attachments to handle large items weighing hundreds of pounds. One specific application is automated package handling. For example, the US Postal Service recently released an RFP asking for pick-and-place robots and gantry traveling robots to handle mail trays, bags, and packages, weighing up to 250 lbs. Another is materials handling in hazardous environments, such as mines or grain mills, where a lost load becomes a potential spark/ignition source.

REFERENCES:
1. "Automated Ammunition Handling Magazine" Advanced Technology Demonstration Proposal (available from Defense Technical Information Center or the first POC below.)
2. Voss, Dan L., "The Case for Automated Ammunition Magazines and New Guns Modularized with Automated Magazines" presented to the ASNE Conference, Washington DC, March 1997

KEY WORDS: robot; hand; gripper; grabber; end effector; magazine

N98-109 TITLE: Control Approach for Heavy Payload Handling Robots

OBJECTIVE: Develop innovative control approaches for robots handling heavy payloads. Desirable improvements include quicker, more accurate motions, control of forces on the robot structure, reduction in the size, mass, and power requirements of motors and actuators

DESCRIPTION: Increased use of robotics to reduce crew size for future ships requires robots that can handle heavy payloads quickly and accurately. Automated weapons magazines, storerooms, and replenishment-at-sea systems are some specific application areas. In the example of an automated gun magazine, robots would be required to extract projectiles weighing up to 300 lbs from storage cells, move them 30 feet across the magazine, and load them into a feed tray, with positioning accuracy at the centimeter level. This topic seeks improved control theory approaches that will provide this type of payload, speed, and precision using the lightest, most efficient, most operationally flexible and least expensive robot possible.

PHASE I: Develop the theory and synthesis techniques for an improved control theory. Demonstrate its performance in

a simulation.

PHASE II: Transfer the control approach to a hardware test bed and show its performance.

PHASE III: Implement the control approach in a military system, such as the magazine for the Next Generation Naval Gun.

COMMERCIAL POTENTIAL: Improved control approaches will have substantial payoffs in all areas of robotics, including production automation, robotic package handling (for example, airline baggage handling, in the Post Office, or at package express companies). Applications in transportation include active suspension, smart skid control, and active cruise control. Because an improved control approach would be essentially, a software change, it could be backfit to existing mechanisms, providing smoother operation, greater precision, and more efficient trajectories.

REFERENCES:

1. Oak Ridge National Laboratory Patent Disclosure "Dextrous Manipulation of Heavy Objects." (Available from Defense Technical Information Center)

KEY WORDS: robotics; control system; precision; automation; magazine

N98-110 TITLE: Rugged, Portable Ground Station for NSFS Targeting

OBJECTIVE: Develop a fire control station that is easily carried by one forward deployed Marine which provides the abilities to monitor or control weapons and surveillance assets launched from ships positioned over the horizon, and to designate targets to those ships and their weapons.

DESCRIPTION: Technology advances in weapon and surveillance systems combined with long range maneuver warfare requirements have created an increasing need for high portability control systems and situation awareness nodes. The Navy is developing very long range weapons to support Marine Corps maneuver units beyond 100 nmi from the ships position, wherein terminal control at the engagement site is feasible. In these maneuver warfare environments, Marines can no longer depend on the classical forms of executing mission objectives. One example is operation with a new targeting and weapon delivery system, the Forward Air Support Munition (FASM). As recently stated by OPNAV staff, however, even a laptop sized computer and control station may not be acceptable for these dismounted maneuver troops.

The goal of this project is to define and evaluate a man-portable control station, which includes imagery display, communications and computational facility. The control station must have minimum impact on all forms of mobility, yet permit simple functional operation, in all environments under engaged conditions. This will permit company or possibly smaller sized maneuver units to obtain tactical situation awareness data or neutralize specific objectives which cannot be readily achieved through conventional call-fire methods. This capability does not replace the functions of imagery analysis, storage/retrieval or interface to other command centers — which would be simultaneously implemented in the ship or shore based command centers. The ground station must be able to use tactical communications to provide target coordinates to the firing ship, and then establish communications with incoming targeting assets and weapons to direct and control them and use the information they develop.

PHASE I: Develop design concepts and conduct technical evaluation of man portable systems suited to the mission objectives. Interface with Navy and Marine Corps development organizations to assure compatibility with operational need. Critical issues may be demonstrated through computer simulation or existing hardware experiments.

PHASE II: Develop a detailed design of a tactical system, supported by additional operational requirements and conduct of control structure analysis. Demonstrate the control station with new or existing hardware under a realistic tactical situation. This could be accomplished in conjunction with other weapon system demonstrations, such as those under the Commandant's Warfighting Lab, or by simulated inputs from other virtual reality environments.

PHASE III: Perform additional design and analysis to construct and demonstrate a fully tactical control station that satisfies operational navy/Marine maneuver warfare requirements.

COMMERCIAL POTENTIAL: A portable control station of this type could be employed in numerous fire-fighting, industrial and environmental applications. Examples include police use at complex crash or disaster scenes, and first-response team use at crash scenes or fires, on-site maintenance, and augmented reality for training. Michael Dertouzous, head of MIT's Laboratory for Computer Science, postulates a "body net" to integrate the currently discrete computer and electronic devices carried by people today—cell phones, tape players, organizers, hearing aids, etc. This SBIR topic can apply this paradigm to the tactical information needs of the Marine in the field, and so will establish a definition for the commercial product.

KEY WORDS: Control station; computer; portable; wearable; targeting; network

N98-111 TITLE: NAVARM Naval Range Extender for Army Artillery Shells

OBJECTIVE: Develop technologies which can greatly extend the range of present and future Army artillery shells through aerodynamic lift and enable their use in future Navy gun systems.

DESCRIPTION: Present and future Army 155 mm artillery shells have been and will be produced in large numbers at low cost. These low costs are essential for Navy gun launched projectiles as well, but the Army shells have ranges which are much too short for Naval fire support applications. Advanced technologies are needed to extended the range of the Army shells while maintaining low cost. Low cost GPS/IMU guidance and navigation systems are already being developed by the Navy for future projectiles. Innovative aerodynamic lifting surface, control, and actuation technologies are desired to combine with these GPS/IMU systems to enable Army shells to achieve long ranges through employment of aerodynamic lift. These new technologies must be configured to be compatible with existing and future Army spin stabilized 155 mm shells, and with future high performance, smooth bore Navy guns in 155 mm or larger bore sizes.

PHASE I: Develop concepts (eg: deployable lifting surfaces) to greatly extend the range of existing and future low cost 155 mm Army shells when used in future high performance Naval guns.

PHASE II: Develop and test prototype components to determine performance and compatibility with Army shells and advanced Naval guns.

PHASE III: Fabricate and test advanced prototype components in full scale flight to validate their performance in greatly extending Army shell range in advanced Naval guns.

COMMERCIAL POTENTIAL: The low cost, rugged actuation and control systems developed in this effort could be utilized in air handling, heating, and air conditioning equipment, forced-air blowers in incinerators, coal- and oil-fired generators, and other industrial plants, and to improve the reliability, safety, and cost of general aviation light aircraft autopilot systems.

REFERENCES: FY96 Competent Munition ATD awarded to Draper Labs, which tightly integrates a micro-miniature Inertial system and a Global position system to form a very low cost navigation for gun projectiles.

KEY WORDS: aerodynamic lifting surface; stability flight control; compact efficient actuators

N98-112 TITLE: Small, Rugged Internal Combustion Engine

OBJECTIVE: Develop a small (5 lb), rugged (gun-launchable), internal combustion engine that runs on a shipboard-safe heavy fuel (high flash point), for application to aircraft propulsion and electric power generation.

DESCRIPTION: Applications in expendable sensors and aircraft, unattended radio stations, and similar portable applications require a compact internal combustion engine. This engine should be exceptionally rugged—suitable for launch from guns and missiles and for delivery by airdrop. Operation after 9000 g setback acceleration is required. The engine must be powered by a shipboard-safe "heavy" fuel (that is, with a high flash point, such as JP-5, JP-8, or JP-11). It should be manufacturable in a low-cost, expendable version (12-hour operating life) and a more durable version for longer operating life. Other specifications are: fit in a 5-inch diameter cylinder, length not to exceed 18 inches, output of 4 brake horsepower, and fuel consumption not to exceed 1 gallon per hour at 70% power, and weight not to exceed 5 lbs.

PHASE I: Design the engine. Show that the design will be suitable for surviving 9000 g setback acceleration

PHASE II: Fabricate a prototype engine. Characterize its performance and demonstrate its acceleration hardness.

PHASE III: The first transition opportunity for this engine is in the Forward Air Support Munition, a gun-launched surveillance, targeting, and precision delivery air vehicle. FASM is being developed by PMS 429, the Naval Surface Fire Support program office.

COMMERCIAL POTENTIAL: An engine this size will bridge the gap in portable energy sources that exists between portable generators in the 50 lb class and 5-lb battery packs. Operation on a high flash point fuel, rather than gasoline, will reduce the hazard associated with gasoline, making the engine suitable for standby generator applications in homes and other buildings where gasoline storage is undesirable. (That is, this engine could be installed in the basement, rather than in a garage or other outbuilding.)

KEY WORDS: Engine; Power; Propulsion; Generator; Internal Combustion; Heavy Fuel

N98-113 TITLE: Robotics - Develop Manipulators To Handle Various Types of Manufacturing Processes

OBJECTIVE: Develop robotic manipulators and controllers to provide coordinated uniform manufacturing processes, plus sensors and software for hands-off operations independent of the fabrication process. This objective is unique because, unlike earlier robotic efforts such as PAWS, it separates the delivery system from the application and. It focuses on the development of a manipulator that can be adaptableed to a broad number of similar applications but which may have very different degrees of complexity. For example, welding, fitting, gluing and grinding require contact with the host surface, while cleaning, blasting, painting and inspection do not require contact.

DESCRIPTION: Develop gantry, articulated arm, and portable robotic manipulators and controllers, including sensors and software for hands-off operations, to coordinate the operation various types of manufacturing processes including cutting, fitting, welding, cleaning, blasting, painting, gluing, and inspection. Development of coordinated system manipulators and redundant axis (i.e. more than six axis) controllers for robotically controlled processes will facilitate large scale production of advanced shipbuilding initiatives such as stainless steel advanced double hull concept and composite topside structures.

PHASE I: Develop a capability to manufacture and integrate robotic manipulators and their controllers, to provide hands-off production processes independent of the fabrication process (i.e. welding, grinding, painting, gluing, inspecting), unlike PAWS which is specific to welding only.

PHASE II: Implement the capability into a prototype and conduct proof of concept testing.

PHASE III: Demonstrate production capability; scale up from prototype to full rate production to meet needs of advanced shipbuilding initiatives.

KEY WORDS: Robotics; Manipulators; Controllers; Articulated; Gantry; Software; Sensors

N98-114 TITLE: Advanced Technologies Leading to Condition Based Maintenance

OBJECTIVE: Define innovative concepts utilizing advanced technologies, such as prognostics, to translate the Navy's Schedule Based Maintenance system into a system in which we conduct all preventative maintenance based on the actual health of that individual equipment.

DESCRIPTION: The highest equipment failure rate can be attributed to starting and stopping equipment, and equipment operation after improper maintenance has been conducted. To reduce the financial burden of these failures, we can feasibly reduce an equipment's required maintenance by accurate predictive diagnostics and conducting maintenance when the equipment dictates the requirement, not when the maintenance is due on a cyclic schedule. Development of these predictive concepts will reduce the equipment's mean time between failure. This is due to the fact that you will be able to take that gear off line prior to failure. By repairing that equipment at its first indication of casualty symptoms, the repair costs are dramatically decreased. New technology in this field could also reduce the Intermediate and Depot level work packages required during availability periods due to the knowledge of an equipment's actual health thus deferring equipment overhauls until absolutely necessary.

PHASE I: Develop a design, structure, and procedures to define and apply condition-based maintenance technology to shipboard equipments, sets, and systems. Identify the procedures for which to diagnose equipment problems and apply then in an marine environment, in an effective and efficient manner. Assess current technology and apply it naval environments. Demonstrate the outlined technology and prototype equipment with a specific system in a shipboard application.

PHASE II: Demonstrate this technology on a total ship basis, to develop the concept's capability and increase the ship's actual material readiness after complete incorporation.

PHASE III: Develop retrofit plans to apply the new technology to all classes of ships.

COMMERCIAL POTENTIAL: Any commercial industry, both marine or other engineering applications, could benefit utilizing the described technology. Financial relief from decreasing repair and maintenance budgets should be a generic gain.

REFERENCES: General articles on Condition Based Maintenance, Naval/Marine Industry Magazines

KEY WORDS: Condition Based Maintenance; Prognostics; Advanced Diagnostics, Material Readiness

N98-115 TITLE: COTS Approach to Information Security

OBJECTIVE: The advent of COTS systems has established a moving target for information security. COTS products and have been designed with less concern over data integrity issues in or outbound information. There is a need to minimize the effort required to maintain good security practices, but also balancing the requirements of information security for military combat systems.

DESCRIPTION: With the increasing usage of COTS, especially in the operating system and device driver domain, military applications have become increasingly more vulnerable to both advertent and inadvertent intrusion. A standardized tailoring of these and other COTS elements would help both the developer and the accreditor when developing embedded military systems. The introduction of commercial networking solutions has further opened the door for security breakdown. Strategies which allow the use of networks, but minimize their vulnerability are needed. Software and hardware aids, both embedded and external, are needed to assist the development and deployment of military systems.

PHASE I: Survey the current security accreditation process. Generate tailorings which support the broad range of commercial operating systems and networking solutions. Demonstrate compliance with the accreditation requirements.

PHASE II: Prototype the process and demonstrate on an actual combat system. Evolve the Phase I work to handle other facets of security including mult-level security issues.

PHASE III: Develop a seamless process and tool set for information security using available commercial products wherever possible.

COMMERCIAL POTENTIAL: With the explosion of the internet and electronic commerce, information security methods have become obsolete. Methods for information security which are application non-specific will represent significant risk reduction in the commercial environments.

KEY WORDS: Infosec, Multilevel security, network security

N98-116 TITLE: Compact Sensor for Measuring Large Strains on the Surface of Elastomers

OBJECTIVE: Enable the measurement of large strains (up to 150%) on the surface of an elastomer (e.g. natural rubber) while the material is submerged in water.

DESCRIPTION: The technology to accumulate and store significant levels of strain energy in an elastomer has been demonstrated by inflation of disks, spheres, etc. The need to accurately measure strains associated with an inflated elastomer is of critical importance to product development, proof testing, and operational condition monitoring. This effort would use existing and new technology to design and fabricate a suitable compact strain sensor for the above application. Ancillary electronics (e.g. amplifiers, signal conditioners) that are not commercially available shall also be considered as part of this effort.

Existing devices for measuring large strains on elastomers include the laser extensometer that is typically used for laboratory material testing of flat samples subjected to homogeneous strains. This type of device is not well suited for underwater applications on curved surfaces subjected to inhomogeneous strains. Birefringent methods that involve coating the part can be used in the large strain regime but require photographing the part in a strained state while underwater. Foil and semiconductor strain gages are not applicable due to small strain limitations (typically <30%).

A compact sensor capable of accurately resolving large strains on the surface of an elastomer while submerged in seawater and deformed requires innovative implementation of existing and new technology.

PHASE I: Develop innovative concept design(s) in sufficient detail to assess sensor performance, size, and cost of a manufactured device.

PHASE II: Fabricate prototype sensors and conduct *in-situ* evaluations under actual or simulated operational conditions. Optimize performance and accuracy while minimizing the sensor size.

PHASE III: Manufacture production sensor packages including operating instructions and specifications.

COMMERCIAL POTENTIAL: The use of elastomers and rubber materials in industry and consumer products is ubiquitous. Large strain measurement capabilities will not be limited to underwater measurements. This will enable manufactures to routinely test strain instrumented prototypes during product development.

REFERENCES:
1. Dally, J.W., and Riley, W.F., Experimental Stress Analysis, 3rd ed., McGraw-Hill, 1991.
2. The Journal of Strain Analysis for Engineering Design, Mechanical Engineering Publications, Ltd., New York, 1976-present. ISSN: 0309-3247

KEY WORDS: strain; sensor; elastomer; transducer; strain gage; rubber

N98-117 TITLE: Combat System Testing & System Integrity Assessment Tools

OBJECTIVE: Develop an innovative low cost automated approach for regression testing & monitoring change control of COTS hardware and software components and associated test concepts/methods which validate use of parts procured for technology refresh, spares and maintenance of the system.

DESCRIPTION: The incorporation of commercial off the shelf (COTS) Hardware and Software in the shipboard environment has meant low cost/high technology systems are now being deployed. The ability of COTS systems to maintain low cost/high is driven by rapid change in COTS technology. This introduces a significant new issue of tracking and validating changes to support the maintenance of these COTS systems. Traditionally all parts were tracked at the piece part level and any changes were completely tested via hot Box testing in the actual system environment. Due to the number of changes that will occur in COTS hardware and software a new methodology of tracking and testing is required to allow for procuring spare parts affordable, and adequate to ensure continued system integrity.

PHASE I: Identify various COTS products to determine the expected rate of engineering change and develop a model or technique which could be used to predict these changes for various classes or types of COTS products. Provide a methodology to be used to monitor changes based on the prediction tool. Using a select group of COTS products validate the prediction tool and monitoring techniques. Provide a technique or method which could be used to determine what change class would require testing and a method to test or validate these changes in the system environment. Perform a sample life cycle cost analysis of these new techniques vs the traditional approach of monitoring all parts/changes and Hot Box testing to demonstrate savings.

PHASE II: Continue to validate the prediction model and monitoring techniques with a larger set of COTS products. Develop and test the methodology defined in phase I which can be used to evaluate the compatibility of a changed asset in the system environment.

PHASE III: Prepare final documentation and implementation of the prediction tool, change monitoring requirements and test validation techniques for deployment and use in multiple system applications and platforms.

COMMERCIAL POTENTIAL: This system could be applied in any work environment where large scale COTS hardware and software systems are used and the need for normal system maintenance involving spares or repair assets are required.

KEY WORDS: maintenance, spares, configuration, change, COTS technology

N98-118 TITLE: Plasma Antenna For Type 18 Periscope

OBJECTIVE: Develop an antenna using plasma technology that can be mounted on a Type 18 periscope and will receive radar signals in the 1 GHZ to 40 GHZ frequency range.

DESCRIPTION: Plasma theory predicts the possibility of using a plasma as an antenna. Theoretically, a plasma antenna could be dynamically reconfigured to receive a wide range of frequencies by changing the ion densities rather than the physical length. A Plasma antenna that could be dynamically reconfigured to detect radar signals between 1 GHZ and 40 GHZ would be a valuable asset to a submarine if it could be installed in a periscope. The size of the antenna would be restricted to the space available in the periscope barrel, which is 7 inches in diameter. It is anticipated that the height of such an antenna would not exceed three inches, excluding pressure boundaries and radome.

PHASE I: The Contractor shall prepare a feasibility study to determine how to design a plasma antenna that can be dynamically reconfigured to detect radar signals in the 1 GHZ to 40 GHZ frequency range. The design must meet the space limitations of the periscope. The feasibility study shall include the type of plasma considered, the theoretical gain and receiving pattern of the plasma antenna, and show that the operating environment was considered in the study. PHASE II: The Contractor shall design the plasma antenna, build and test an Engineering Development Model, and prepare developmental drawings.

PHASE III: The plasma antenna will be installed on a submarine periscope and tested at sea. Mass production of the plasma antenna will be evaluated, as well as reducing the size of the antenna to make it portable. Possible dual-use applications include radar detectors for law enforcement, portable extremely high frequency transmitting and receiving antennas for satellite transmissions, miniature commercial radios.

COMMERCIAL POTENTIAL: While signal transmission is not a part of this design, it is clear that the antenna can transmit as well

as receive a signal. It is also anticipated that frequencies much higher and much lower than the stated frequencies will be able to be transmitted or received with similar designs. Since, theoretically, the size of the plasma antenna should be considerably smaller than a metal antenna for the same frequency, there is great commercial potential to devise miniaturized and portable antennas with this technology.

REFERENCES:
1. Roussel-Dupre, R. Miller Radiative Properties of a Plasma Moving across a Magnetic Field Physics of Fluids B 5(4), April 1993
2. America Nucleonics Corporation Plasma Antenna in a Nuclear Environment, prepared for Defense Atomic Support Agency, DSA 1733, 7 October 1965.

KEY WORDS: plasma; antenna; radar; electronic warfare; periscope; extremely high frequency

N98-119 TITLE: Use of Common Object Request Broker Architecture (CORBA) to Control Classified Data Distribution

OBJECTIVE: The objective of this topic is to define and develop a process for use by application programmers to individually tag data with a classification description, and to use this description to regulate data distribution to clients.

DESCRIPTION: CORBA is actually application Middleware. Middleware has become a critical part of software development because companies now take advantage of middleware code to integrate their present and future applications. Low level integration is costly and causes delays in application development. CORBA Interface Design Language (IDL) bridges programming languages, operating systems, networks and object systems with a standard data distribution toolbox.

Use of CORBA to tag data with classification descriptors facilitates multi-level security network implementation. The data paths of these objects can be tracked. Access to specific objects can be granted by matching the classification of objects to the registered classification of the client requesting the objects. This approach could allow systems classified TS/SCI to co-exist on networks with systems classified Secret and lower.

PHASE I: Develop a design of CORBA and its mechanisms of invocation call-paths for methods through the Object Request Broker (ORB) to control data access.

PHASE II: Implement the design of Phase I in a Tactical network (eg: ATM) environment of at least 8 workstations (PC and UNIX mix). A test scenario shall be developed and demonstrated showing how computers are networked together can have access to multiple data object servers with a mixed of multiple classifications assigned to each object on each data server. At least 3 of the computers will have classification restrictions such that they will not have access to all data objects while having access to all of the data servers present on the network. It shall be shown that at no time are these 3 workstations allowed to access objects which are above their classification status.

PHASE III; The method generated in Phase II will be introduced to an existing Navy system for implementation in a multi-level secure environment and tested shipboard.

COMMERCIAL POTENTIAL: This SBIR topic would have potential commercial application to software developers producing application in environments with multiple user classification and access restrictions.

REFERENCES:
1. http://infosec.nosc.mil/main.html
2. http://www.qds.com/people/apope/ap_corba.html
3. http://www.acl.lanl.gov/CORBA/#DOCS
4. http://www.dtic.mil/dstp/DSTP/97_dtap/informat/ch030303.htm#TABLE III-7

KEY WORDS: Security, CORBA, Classification, Information Technology

N98-120 TITLE: Plug and Play Adjunct Processing To Support Rapid Technology Insertion

OBJECTIVE: In order to accelerate the infusion of new algorithms and processing capabilities into the fleet, a platform independent deployment strategy which will enable various organizations to easily install temporary H/W and S/W onto shipboard platforms is needed. The concepts used must balance the freedom of advanced research methods with the discipline needed to deploy technology on a submarine. Tools and methodologies must be developed to provide an adaptable open test platform capable of exploiting the legacy system interfaces and minimizing the cost of technology infusion.

DESCRIPTION: The incorporation of commercial off the shelf Hardware and Software along with industry standard interfaces such as VME, FDDI, Ethernet and POSIX on shipboard platforms have made it possible to now bring real hardware and software onto these platforms and rapidly integrate it with the other system hardware and software resources for real time access to raw element data and display resources. This effort will develop the necessary interface standards and conventions required to allow access to these system resources while providing the required isolation to ensure that performance or functionality is not affected or degraded for required system operations.

PHASE I: Perform a study on what industry standards and conventions for both hardware and software are required to provide access to the necessary raw element data and display resources. Develop a set of system interface requirements and guidelines along with resource utilization limits that will ensure existing system components are not affected when adjunct processing hardware and software is added to the system.

PHASE II: Develop and test a generic controller interface which provides the necessary hardware and software isolation at the same time allowing access to a set of system resources with the requirements and guidelines outlined in phase I. Demonstrate the capability to integrate a set of independent hardware/software assets with the controller which shows access to the system resources without any affects on the main system resources.

PHASE III: Prepare final hardware and software implementation, requirements and resource utilization to allow the controller interface to be used in multiple system applications and platforms.

COMMERCIAL POTENTIAL: This system could be applied in any work environment involving the need for rapid prototype testing of system add-on capabilities in the real environment while ensuring no effect on the main system resource.

KEY WORDS: adjunct, processing, algorithms, advanced, technology

N98-121 TITLE: High Power Switching for MF Active Sonar Aperture Selection

OBJECTIVE: Develop new solid state techniques to switch high power active acoustic transmission pulses and select appropriate transmission apertures in submarine medium frequency spherical array sonar systems.

DESCRIPTION: Current medium frequency active sonar systems use electro-mechanical devices to switch transmission pulses and select transmission apertures. The mechanical switching servos and relays are obsolete and prone to failure. This effort would incorporate new solid state technology and COTS components and equipment to perform the switching functions.

PHASE I: Develop a concept to use new solid state technology and COTS components and equipment to perform the pulse switching functions in the MF active sonar systems. Design and develop circuit schematics and component selections to perform the switching functions. Perform CAE circuit analysis to model and verify system performance.

PHASE II: Develop and fabricate a brass-board prototype unit and perform a proof of concept demonstration of the circuits developed in Phase I.

PHASE III: Based on a successful Phase II effort, develop a prototype model for qualification, test and evaluation, and production purposes, including any required supporting software and documentation, for a MF active sonar transmission pulse switching unit which can be integrated into an existing submarine sonar system.

COMMERCIAL POTENTIAL: This effort has extensive application in commercial acoustics and sonar systems including high-power acoustic power amplifiers and seismic survey equipment associated with oil and gas exploration.

KEY WORDS: sonar; active; submarine; pulse; switching; transmission

N98-122 TITLE: Low Cost COTS Replacement for Versa Module Europe (VME) Chassis Computing Systems

OBJECTIVE: Explore the use of COTS open-system computing architectures as an expandable yet low-cost replacement for legacy VME computing systems in submarine sonar systems.

DESCRIPTION: Many of the sensor, data and display processing, equipment currently under development and production for submarine systems use Versa Module Europe (VME) architecture. The VME architecture, although adequate for current requirements, stepping stone to the next generation of technology. This effort would explore the use of other open-system COTS computing architectures to perform the processing functions of the processing systems at lower life-cycle cost.

PHASE I: Develop a concept to use alternative computing architectures and COTS equipment to perform signal conditioning, signal processing, and display and data transfer processing for submarine sensor systems. Identify system and

interfacing requirements. Design and develop system-level block diagrams and equipment selections to perform the processing functions. Perform CAE system analysis to model and verify the computing system performance. Provide system life-cycle cost analysis.

PHASE II: Integrate a brass-board prototype unit and perform a proof of concept demonstration of the computing system developed in Phase I.

PHASE III: Based on a successful Phase II effort, develop a prototype model for qualification, test and evaluation, and production purposes, including any required supporting software and documentation, for use in existing submarine sensor systems.

COMMERCIAL POTENTIAL: This effort has extensive application in commercial acoustics, sonar, and embedded C3I systems.

KEY WORDS: sonar; COTS; computer; architecture; processing; VME

N98-123 TITLE: Low Cost Hydrophone Manufacturing & Assembly

OBJECTIVE: Develop low cost hydrophone assemblies.

DESCRIPTION: Hydrophone assemblies have continued to keep the costs of acoustic sensors high. These costs are driven by use of conventional ceramics and assembly techniques. New composite ceramics are evolving through continued advances in materials technology, but designs are still such that automation is very difficult. Although some advances have been made in the type of materials used, the higher-level assembly is still very expensive compared to the cost of the basic components ($40 in materials becomes a $1,600 completed assembly). The offeror should be knowledgeable in the art of piezo-electrics and aware of previous efforts in this area, including a familiarity with efforts by ONR, NRL, and NAVSEA prime contractors and suppliers. Offerors should coordinate their approach with, and complement, existing in the field of Hydrophones. Previous efforts have focused on radically new technologies, and provided little benefit to existing systems and ceramics based hydrophone systems. Innovations are possible in the use of new materials, strain relief of components, new connectors, pottted assemblies, new ceramic materials, and use of new spacer or acoustical (dipole) focusing techniques. Technical innovation is necessary in the area of leakage current from the assembly and sensitivity to pressure, which affect manufacturing yield and thereby unit cost.

PHASE I: Identify and develop designs using new ceramic materials, design form-fit replacement assemblies, and assess manufacturability of various designs.

PHASE II: Design, build, and test hydrophone assemblies.

PHASE III: Produce quantities of the system which would be used on various US Navy platforms. Provide repair and spare parts support. Sensor manufacture and assembly has been successfully subcontracted to small business concerns under several towed systems manufacturing contracts.

COMMERCIAL POTENTIAL: Commercial oil exploration systems (towed acoustic streamers).

KEY WORDS: Acoustic sensors; towed arrays; hydrophone; ceramics; cable assemblies;

N98-124 TITLE: Sonar Performance Enhancement in the Littoral Environment

OBJECTIVE: Research the mechanism of surf-generated noise propagation in the littoral environment to better predict the littoral acoustic environment and thereby enhance sonar performance.

DESCRIPTION: Surf-generated noise may propagate seaward within littoral waters to ranges greater than 10km and dominate measured broadband ambient noise levels (Stewart, et al). The submariner can achieve significant tactical advantage with an improved understanding of this natural phenomenon. It is poorly understood what types of shore/near shore environments, i.e. headlands, long sandy beaches, etc., and what range dependent water column, bottom and sub-bottom characteristics both support and attenuate propagation of surf-generated and other coastal noise. The proposed solution to this problem includes 1) selection/development of a suitable acoustic model, 2) research of existing pertinent environmental data sets (bottom, sub-bottom geoacoustic properties and water column properties) to obtain acoustic model inputs, and 3) measurement of specific selected relevant environments not previously studied to obtain model inputs. This solution also involves 4) first running the model to determine shallow water transmission loss behavior of a specific coastal environment and then 5) measuring actual transmission loss in that environment to validate the model. The final pieces of the solution are 6) to assess the contribution to the littoral acoustic menvironment of surf-generated noise and 7) to evaluate and optimize sonar performance in this environment.. Tactical sonar optimization in the littoral environment should be developed as a function of 1) geographical location (unique bottom, sub-bottom,

and water column characteristics), 2) frequency, 3) surf type (coastal geography), and 4) competing ambient noise mechanisms (primarily shipping).

PHASE I: Research and develop a suitable preliminary shallow water propagation loss model that takes into account water column acoustic and bottom/sub-bottom geoacoustic properties that are range dependent from coast seaward as well as longshore. Prepare and submit for Government acceptance a three part data measurement plan to first obtain range dependent water column acoustic and bottom/sub-bottom geoacoustic properties for coastal environments; second to measure propagation loss in the shallow water environment and validate the shallow water propagation loss model; and third to include measurement of the surf-generated noise contribution to the ambient noise field in the chosen environment in preparation for assessing and optimizing sonar performance.

PHASE II: Collect and then analyize the environmental data described in Phase I, from unclassified coastal environments with prominent headlands and bays with deep water seaward, such as the California or Oregon coast, and those with more linear shorelines and a more gentle shelf slope such as the North Carolina coast. Other more tactically important areas could be analyzed, however, the analysis of existing data for such areas and collection and analysis of new data for such areas may require a security clearance. Include measurement of actual transmission loss in the environment studied to validate the acoustic model, and collect surf noise data using a sonar system of interest.

PHASE III: Evaluate and optimize sonar performance in light of surf noise and other ambient noise effects in the environment studied and determine how the acoustic model can then be used to predict sonar performance given geographical location (bottom, sub-bottom, and water column characteristics), frequency, surf type (coastal geography), and competing ambient noise mechanisms (primarily shipping).

COMMERCIAL POTENTIAL: Recently, the impact of man-made noise sources near shore on ocean fauna has caused great controversy, but no background near-shore noise measurements or shallow water acoustic models existed to support or refute contending arguments. The proposed research would be a great value to both the marine biologist and to global warming programs which rely on a detailed understanding of acoustic energy propagation throughout the ocean environment.

REFERENCES:

1. Stewart, CDR M., Dr. O. B. Wilson, Dr. J. H. Wilson, and Dr. R. Bourke. Shallow Water Ambient Noise Caused by Breaking Waves in the Surf Zone. December 1994

KEY WORDS: acoustics; ambient noise; littoral; sensors; shallow water; sonar

N98-125 TITLE: <u>Optimized Laser Scanning Doppler Vibrometer for Measurements on Rotating Propellers in Water</u>

OBJECTIVE: Develop a laser scanning vibrometer capable of accurately measuring full field vibration patterns point by point field at many locations on propeller blades operating in water.

DESCRIPTION: Whereas measurements of this type have been reported by a number of investigators, the accuracy has been limited by the numerous error mechanisms which cause pseudo vibrations. Most typically measurements on the rotating components are obtained by tracking a particular fixed point using scanning laser 1,2. The pseudo vibration generating mechanisms include: non-coincidence of the rotational axis of the propeller with the measuring laser beam; pseudo signal corresponding to apparent once per revolution rotation of the propeller blade with respect to the laser beam, and errors introduced by laser transmission through observation windows. What is sought is a methodology and a device which overcomes these error mechanisms, thereby providing accurate quantitative measurements of the propeller vibrations.

PHASE I: Demonstrate system for accurately measuring point to point vibrations of a rotating propeller in water. Line of sight measurements correctable to out of plane vibration are acceptable. System should be capable of measuring vibration velocity levels smaller than one micrometer/sec for frequencies up to 10 KHz for rotational speeds up to 600 RPM.

PHASE II: Develop prototype system for measurements on propellers in water tunnel as well as for underway ships and small and large scale ship models.

PHASE III: Configure system into portable, computer controlled device with the necessary post processing and imaging outputs required for both commercial and military applications.

COMMERCIAL POTENTIAL: There is an industrial need for a device which can measure the vibration on both low and high speed turbomachines. Such a device would provide a tool for diagnosing noise generating mechanisms as well as fatigue related effects. Whereas the device sought does not need to operate at very high speeds, the technology developed under this topic could be extended to applications for high speed turbines.

REFERENCES:
1. Bucher I., P. Schmiechen, D.A. Robb, D.J. Ewins. "A laser- based measurement system for measuring the vibration on rotating disks," SPIE Vibration Measurements, Vol. 2358, pp398-408. (1994)
2. Castellini, P. And C. Santolini, "Vibration measurements on blades of naval propellers rotating in water," Proceedings of the Second International Conference on Vibration Measurements by Laser Techniques," SPIE Vol. 2868, pp186-194, (1996)

KEY WORDS: Laser; Doppler; Vibrometer; LDV; propeller measurements; rotating

N98-126 TITLE: Combat Systems COTS System Administration

OBJECTIVE: Facilitate on-board, real-time maintenance, fault diagnosis and repair, of COTS Combat System networks. Provide an interactive tool for complex problems like bringing replacement components back online.

DESCRIPTION: Performance Support Systems combine diagnostics, technical data, and a dynamic knowledge base into a single product. As the Navy moves to a client/server system architecture for combat systems, system maintenance and administration will become increasingly technical. The commercially available tools available today to assist the sailor maintain client/server networks fall short of providing solutions to system problems. These tools will identify when a component of the network drops off-line, but provide no guidance on the corrective action, or the cause of the fault. This topic calls for the research and development of a system administration tool that combines diagnostics, technical data, such as the Interactive Electronic Technical Manual (IETM), training curricula, such as Interactive Courseware (ICW), and a dynamic knowledge base. This would allow the sailor to diagnose a system component fault or failure, determine the appropriate procedure to correct the problem, and determine how to ensure the problem does not occur again. Having an interactive system maintenance and troubleshooting tool will yield minimum down time of mission-critical components and potentially reduce training and manning.

PHASE I: Design Concept of a Performance Support System for System Administration of Navy ship-board combat systems. The concept must demonstrate how the diagnostic procedure would invoke the technical and training documentation, and how fault/failure information would be captured.

PHASE II: Prototype and test the Performance Support System for System Administration on a mature system in a laboratory environment. Demonstrate the systems use of IETM, ICW, and the dynamic knowledge base. Provide hooks for future growth and system enhancements. Refine system based on operator feedback.

PHASE III: Integrate the Performance Support System for System Administration into the NSSN Non-Propulsion Electronics System (NPES) network architecture. The product shall be fully integrated with subsystem IETMs, ICW, and be fully capable of recording and learning from system faults/failures.

COMMERCIAL POTENTIAL: Most commercially available system management tools will identify when a component drops off of the network. This product can potentially take these tools one step forward by identifying the cause of the failure, and the procedure to restore the component. This application is not military unique, and could be applied to any commercial network that has adequate technical documentation.

KEY WORDS: System administration, automated, diagnostics, manning reduction, Performance Support Systems

N98-127 TITLE: Next Generation Combat System Display Concepts

OBJECTIVE: Presentation of sonar information can be improved significantly by exploiting multimedia and signal processing technology in a manner that provides a more intuitive look and feel to the operator. Improvements to traditional methods must stimulate real time, spatial-visual and audio responses. A virtual reality approach to the sonar system sensor data can greatly improve the fleet's effectiveness while reducing training requirements.

DESCRIPTION: While the introduction of Commercial Off The Shelf (COTS) systems have advanced the signal processing capabilities of submarine platforms, operator controls and displays have not changed significantly with this new technological enhancement. While the sonar operator will benefit from more information available to him, managing this information has become a formidable challenge. In high contact density scenarios, operators can easily become overloaded which can result in missed detections at nominal detection ranges. Innovative data presentation techniques that provide intuitive and clear representations of the acoustic data are needed to reduce information overload to the operators. A three-dimensional sonar detection display could provide this information reduction; additional innovations are sought to accomplish this goal. Solutions should adhere to the X-windows MOTIF Graphical User Interface Standard and/or OpenGL.

PHASE I: Develop innovative Sonar Data Presentation concept(s) founded on the GUI MOTIF Standard and the control and display methodologies of available Submarine Sonars. The performance capabilities of the innovative display must be superior to existing Sonar Data Presentations, permitting the operator to achieve better identification of targets and target tracks in less time and with less fatigue.

PHASE II: Design and fabricate a 'brass-board' prototype, and perform a proof of concept demonstration on selected display candidates developed in Phase I of this effort.

PHASE III: Based upon a successful Phase II effort, develop a prototype model for qualification, test, and evaluation and production purposes, including supporting software and documentation, for a control and display system which can be integrated into an existing submarine sonar system.

COMMERCIAL POTENTIAL: These display techniques can be transferred to other areas of the commercial world in which a simplification of data presentations is required. Some other applications include medical imaging, air traffic control radar systems, and potentially digital photographic image processing.

KEY WORDS: MOTIF; Advanced GUI; Three Dimensional Displays; Data Fusion; Information Reduction;

N98-128 TITLE: Migration of Advanced Development and COTS Applications to Tactical Operating Environments

OBJECTIVE: The objective of this topic is to develop a common operating environment to facilitate the rapid infusion of advanced development and COTS applications into legacy tactical systems.

DESCRIPTION: Because of the strict performance requirements of tactical systems (e.g., real-time processing, reliability, database structures, etc.), legacy tactical systems have relied on unique operating environments, which make the transition of advanced development and COTS products technically challenging and cost prohibitive. A common operating environment, imposed on both advanced development and tactical system developers, will provide standardization of product interfaces and ease the migration of technology into tactical systems.

PHASE I: Define critical technical parameters and define a profile or set of profiles to meet those parameters. At the end of the Phase I, an approach, high level design, and profile with perfromance predictions will be selected for further testing.

PHASE II: A demonstration employing the techniques identified in Phase I using PEO-USW ASTO and COTS products will be performed and measured against the predictions developed in Phase I.

PHASE III: A full system design will be developed, applying the principles generated in the previous phases, to meet tactical requirements.

COMMERCIAL POTENTIAL: Use of a common operating environment will facilitate the infusion of COTS products and open system interfaces into tactical systems, which is of benefit to the commercial hardware manufacturers and software developers..

KEY WORDS: Submarine; COTS; Advanced Development; Software Migration;

AIR FORCE
PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio. The Air Force SBIR Program Executive is R. Jill Dickman, (800)222-0336. **DO NOT** submit SBIR proposals to the AF SBIR Program Executive under any circumstances. Addresses for proposal submission and numbers for administrative and contracting questions are listed on the following pages, AF-2 through 4.

Technical questions may be requested using the DTIC SBIR Interactive Technical Information System (SITIS). For a full description of this system and other technical information assistance available from DTIC, please refer to section 7.1 on page 15 of this solicitation.

Air Force Nine-Month Phase I Contract

For the Air Force, the contractual period of performance for Phase I shall be nine (9) months, and the price shall not exceed $100,000. No proposal with a contractual period of performance less than nine (9) months shall be considered.

The primary research must be accomplished during the first six months of the contract. The price of the primary research in the first six months will not exceed $80,000. It is the bulk of the research for the Phase I effort. The primary research effort, alone, is used to determine whether the AF will request a Phase II proposal. The proposal, alone (including the Fast Track application), shall decide who will be selected for Phase II. Our evaluation of the primary research effort and the proposal will be based on the factors listed in the solicitation.

Phase II proposals are by invitation only (all Fast Track applicants will be invited). If requested, the Phase II proposal must be submitted within six months from the start of Phase I to ensure that the proposal will be evaluated and is eligible for award. After the first six months, additional related research must be conducted that furthers the Phase I effort and puts the small business in a better position to start Phase II, if awarded. The last three months of the nine-month technical effort will not be considered in the evaluation process leading to Phase II awards.

The last three months of the nine-month Phase I contract will provide project continuity for all Air Force Phase II award winners so no modification to the Phase I contract should be necessary. The Air Force will accept proposals for modifications to maintain project continuity under special circumstances such as the Fast Track.

Air Force Cost Proposal

Although proposals, including costs, are limited to 25 pages, be prepared to submit further documentation to substantiate costs if selected for an award; the contracting officer may request further information to facilitate the contracting process.

Air Force Fast Track

Detailed instructions on the Air Force Fast Track and Phase II proposals, consistent with this solicitation, will be given out by the awarding Air Force directorate along with the Phase I contracts.

PROPOSAL SUBMISSION INSTRUCTIONS

For each Phase I proposal, send one original and four (4) copies to the office designated below. Be advised that any overnight delivery may not reach the appropriate desk within one day. Be sure to read the Air Force instructions on the previous page for the nine-month Phase I contract to avoid the rejection of your proposal. To request notification of proposal receipt, send request (Ref A on page Ref 1) with a self-addressed stamped envelope. Do not call to ask whether your proposal has been received; due to time constraints, we will not be able to answer such telephone calls.

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
	(Name and number for mailing proposals and for administrative questions)	(For contract questions only)
AF98-001 thru AF98-027	Armstrong Laboratory AL/XPTT (Belva Williams) 2509 Kennedy Circle Brooks AFB TX 78235-5118 (Belva Williams, (210) 536-5429)	Don Norville (210) 536-6393
AF98-028 thru AF98-032	Geophysics OL-AA Phillips Laboratory/XPG SBIR Program (N.Dimond) 29 Randolph Rd, Bldg 1107, Rm 240 Hanscom AFB MA 01731-3010 (Ms Noreen Dimond, (617) 377-3608)	Mr. John Flaherty (617) 377-2529
AF98-033 thru AF98-044	Lasers & Imaging SBIR Program (R. Hancock) 3550 Aberdeen Ave SE, Bldg 497, Rm 239 Kirtland AFB NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Francisco Tapia (505) 846-5021
AF98-045 thru AF98-054	Propulsion OL-AC Phillips Laboratory/RKTC SBIR Program (S. Borowiak) 4 Pollux Dr Edwards AFB CA 93524-7760 (Ms Sandra Borowiak, (805) 275-5617)	Ms. Liliana Richwine (805) 277-3900 x2229
AF98-055 thru AF98-059	Space Experiments SBIR Program (R. Hancock) 3550 Aberdeen Ave SE, Bldg 497, Rm 239 Kirtland AFB NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Francisco Tapia (505) 846-5021

AF98-060 thru AF98-096	Space & Missiles Technology Phillips Laboratory/XPI SBIR Program (R. Hancock) 3550 Aberdeen Ave SE, Bldg 497, Rm 239 Kirtland AFB NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Francisco Tapia (505) 846-5021
AF98-097 thru AF98-105	Advanced Weapons & Survivability Phillips Laboratory/XPI SBIR Program (R. Hancock) 3550 Aberdeen Ave SE, Bldg 497, Rm 239 Kirtland AFB NM 87117-5776 (Mr. Robert Hancock, (505) 846-4418)	Mr. Francisco Tapia (505) 846-5021
AF98-106 thru AF98-144	Rome Laboratory RL/XPD (Margot Ashcroft) 26 Electronic Parkway Rome NY 13441-4514 (Margot Ashcroft, (315) 330-3021)	Joetta Bernhard (315) 330-2308
AF98-145 thru AF98-171	Avionics Directorate WL/AAOP 2241 Avionics Cir. Bldg. 620 Wright-Patterson AFB OH 45433-7318 (Marleen Fannin, (937) 255-5285)	Terry Rogers (937) 255-5830 Bruce Miller (937) 255-7143
AF98-172 thru AF98-186	Flight Dynamics Directorate Wright Laboratory WL/FIIC, Bldg 45 Wright-Patterson AFB OH 45433-7542 (Madie Tillman, (937) 255-5066)	Terry Rogers (937) 255-5830 Bruce Miller (937) 255-7143
AF98-187 thru AF98-205	Materials Directorate WL/MLIP 2977 P St, Ste 13 Wright-Patterson AFB OH 45433-7746 (Sharon Starr, (937) 255-7175)	Terry Rogers (937) 255-5830 Bruce Miller (937) 255-7143
AF98-206 thru AF98-225	Armament Directorate WL/MNPB 101 W Eglin Blvd, Ste 140 Eglin AFB FL 32542-6810 (Richard Bixby, (904) 882-8591)	Lorna Tedder (904) 882-4296
AF98-226 thru AF98-231	Manufacturing Technology Directorate WL / MTX 2977 P St, Ste 6, Bldg 653 Wright-Patterson AFB OH 45433-7739 (Marvin Gale, (937) 255-4623)	Terry Rogers (937) 255-5830 Bruce Miller (937) 255-7143

AF98-232 thru AF98-250	Aero Propulsion & Power Directorate WL/POM 1950 Fifth St, Bldg 18, Rm 105A Wright-Patterson AFB OH 45433-7251 (Dottie Zobrist, (937) 255-2131)	Terry Rogers (937) 255-5830 Bruce Miller (937) 255-7143
AF98-251 thru AF98-253	San Antonio ALC SA - ALC / TIEN 485 Quinten Roosevelt Rd. Kelly AFB TX 78241-6416 (Dave Grubb, (210) 925-4225)	Kevin Shackelford (210) 925-7263
AF98-254 thru AF98-256	Oklahoma City ALC OC-ALC / TIET 3001 Staff Drive Suite 2AG70A Tinker AFB OK 73145-3040 (Don Boedeker, (405) 736-5567)	David Cricklin (405) 739-4468
AF98-257 thru AF98-259	Sacramento ALC SM-ALC / TI-5 5225 Bailey Loop, Bldg. 243C McClellan AFB CA 95652-2510 (Cpt Paul Simonich, (916) 643-2010)	Joseph St. Clair (916) 643-0581
AF98-260 thru AF98-262	Ogden ALC OO-ALC / TIET 5851 F Avenue Hill AFB UT 84056-5713 (Bill Wassink, (801) 777-2977)	Martha Scott (801) 777-0199
AF98-263 thru AF98-270	Warner Robins ALC WR-ALC / TIEC 420 Second Street, Suite 100 Robins AFB GA 31098-1640 (Lt. Bill Braasch, (912) 926-6617)	Cheryl Ficklin (912) 926-9086
AF98-271 thru AF98-277	Air Force Development Test Center AFDTC / DRX 101 W. D Avenue, Suite 129 Eglin AFB FL 32542-5495 (James Kinlaw, (904) 882-8096)	Cpt. Madalena Dama (904) 882-4141
AF98-278 thru AF98-280	46th Test Group XPX 872 Dezonia Drive Holloman AFB NM 88330-7714 (Lt Christina Priest, (505) 475-1230)	Elizabeth Gordon (505) 475-1024

AF98-281 thru AF98-287	Air Force Flight Test Center AFFTC / XPST 195 East Popson Avenue Edwards AFB CA 93524-6843 (Abe Atachbarian, (805) 275-9266)	Donna Thomason (805) 277-3900 x2277
AF98-288 thru AF98-295	Arnold Engineering Development Center AEDC / DOT 1099 Avenue C Arnold AFS TN 37389-9011 (Kevin Zysk, (615) 454-6507)	Gloria Fairchild (615) 454-7841
AF98-296	Sacramento ALC SM-ALC / TI-5 5225 Bailey Loop, Bldg 243C McClellan AFB CA 95652-2510 (Cpt Paul Simonich,(916) 643-2010)	Joseph St. Clair (916) 643-0581
AF98-297	Air Force Flight Test Center AFFTC / XPST 195 East Popson Avenue Edwards AFB CA 93524-6843 (Abe Atachbarian, (805) 275-9266)	Donna Thomason (805) 277-3900 x2277
AF98-298	Air Force Development Test Center AFDTC / DRX 101 W. D Avenue, Suite 125 Eglin AFB FL 32542-5495 (James Kinlaw, (904) 882-8096)	Cpt. Madalena Dama (904) 882-4141

SUBJECT/WORD INDEX TO THE AIR FORCE SBIR SOLICITATION

AIR FORCE 98.1TOPICS

ARMSTRONG LABORATORY, BROOKS AFB TX

AF98-001	Human Systems / Subsystems Research
AF98-002	Human Centered Technologies for Information Superiority
AF98-003	New Emission Control Technology for Hydrazine Fuels
AF98-004	Conversion Coating Process for Large Area Aluminum Alloy Surfaces
AF98-005	Real-Time Characterization & Monitoring of Particulate Matter Emissions
AF98-006	Hydrocarbon & Volatile Organic Compound Oxidation Catalysts at Standard Temperatures & Pressure
AF98-007	Methodology to Assess In-Situ Microbial Potential for Anaerobic Remediation
AF98-008	Advanced Analytic Sonic Boom Underwater Propagation Analysis
AF98-009	Automated Cell Culturing & Exposure Chamber
AF98-010	Intell. Agent for Mining Occupational, Personal, & Training Data on the Web
AF98-011	Dynamic Force-on-Force: C3 Air/Space Operator / Manager Training
AF98-012	Dist. Methods Assessing Workgroup, & Team Eff, Performance & Readiness
AF98-013	Java Tools for Development & Delivering Distributed Training Over The Internet
AF98-014	Instructors Associate for Training & Evaluating Teamwork Skills
AF98-015	Advanced Voice Recognition Technologies
AF98-016	Low-Cost Eye Tracker for Head-Mounted Wearable Computer Display
AF98-017	Advanced Audio & Virtual Sensory Interfaces
AF98-018	Automatic Focusing Night Vision Goggle
AF98-019	Coordinated Team Performance in Complex Operational Systems
AF98-020	Sensor Fusion & Information Warfare
AF98-021	Information Visualization Worlds in Air Operations Centers
AF98-022	Ceramic Oxygen Generator
AF98-023	Ambul Psychophysical Oper State Mon/Recorder/Adaptive Interface Control
AF98-024	Enhancing Aviator Performance through Psychological Skills Training
AF98-025	Affective Interfaces for Complex Crises Situations
AF98-026	Instructional Designers Engineering Associate
AF98-027	Dev & Integration of MEMS Based Sensor Technology with E-Smart

PHILLIPS LABORATORY - GEOPHYSICS, HANSCOM AFB MA

AF98-028	Optical Sensors & Algorithms for Optimization of Target-to-Background Contrast
AF98-029	Range-resolved Continuous-Wave Lidar for Operation in the Visible-UV Range
AF98-030	Conductive Polymer Detectors for Chemical & Biological Agents
AF98-031	Weather Forecast Aid in Conventional Data-Sparse Areas
AF98-032	Meteor Shower Impact on Upper Atmosphere

PHILLIPS LABORATORY - LASERS & IMAGING, KIRTLAND AFB NM

AF98-033	Dual Use Development of Laser Technology
AF98-034	Dual Use Development of Optical Sensing/Data Handling
AF98-035	High-Power,1.9 micron Wavelength Semiconductor Laser Linear Arrays
AF98-036	Novel Packaging for High Efficiency Diode-Pumped Lasers
AF98-037	Wavefront Detection with a Wide Dynamic Range
AF98-038	Coherent Oxygen/Iodine Laser for Environmental Remediation
AF98-039	High Power Eye-Safe Laser Diodes with Low Alpha Structures
AF98-040	Eye-Safe, Infrared Laser Communicator
AF98-041	Spectral Imaging
AF98-042	Remote Sensing
AF98-043	Small Inertial Attitude Reference System
AF98-044	Contamination Control for Space-Based Optical Systems during Ground Operations & Storage

PHILLIPS LABORATORY - PROPULSION, EDWARDS AFB CA

AF98-045	Advanced Rocket Propulsion Technologies
AF98-046	Innovative Radiative Transfer Modeling for Rocket Exhaust
AF98-048	New Approaches to Energetic Materials Decomposition Mechanism & Kinetic Studies
AF98-049	Optical-Quality Measuring Device (OQMD)
AF98-052	Optical Health Monitoring System for Propulsion
AF98-053	Pilot Plant Production Technique for Quadricyclane
AF98-054	Simulation Tool Development for Analysis of Acoustic Propulsion System Resonance

PHILLIPS LABORATORY - SPACE EXPERIMENTS, KIRTLAND AFB NM

AF98-055	Advanced Integrated Systems and Devices for Space Applications
AF98-056	Space Qualified Precision Deployable / Controllable Optical Support Structures
AF98-057	Acceleration Compensated Master Oscillator
AF98-058	Mechanically Hard, Event Recorder with Nonvolatile Memory
AF98-059	Precision-Guided Payload Decelerator / Descent & Recovery Systems

PHILLIPS LABORATORY - SPACE & MISSILES TECH, KIRTLAND AFB NM

AF98-060	Space Systems Technology Development
AF98-061	Multifunctional Structures for Space-Based Radar Antennas
AF98-062	Smart Sensing and Information Processing
AF98-063	Graphical Visualization Framework for Representing Uncertainty in Dynamic 3-D Data
AF98-064	Remote Tracking
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AF98-067	Lightweight Composite Launch Vehicle Fairings with Integrated Damping
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AF98-069	Innovative Space Power Technology
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AF98-071	Acoustic Suppression for Precision Equipment in Aircraft Interiors
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AF98-073	Autonomous Satellite Technologies
AF98-074	GPS / INS Solution to Launch Vehicle Guidance, Navigation, Range Safety Systems
AF98-075	Variable-Resolution Simulation for Multiple Applications
AF98-076	Case-Based Retrieval Approach for Improving Mission Rule
AF98-077	Adjustable, High Efficiency L-Band High Power Amplifier
AF98-078	Broad Tuning Range VCXO for Space Clock Applications
AF98-079	Multi-level Modeling & Simulation Techniques for Electronic Systems
AF98-080	Very High Efficiency DC-DC Converter Development
AD98-081	Advanced Lightweight Structures for High Frequency Antennas
AF98-082	Next Generation Spacecraft Bus Structures
AF98-083	Very High Efficiency Solar Cell
AF98-084	Automated Contamination Control for Space-based Sensors
AF98-085	Distributed, Embedded Structural Monitoring Sensor Networks for Spacecraft/Solid Propellant
AF98-086	Autonomous Message Routing Algorithms
AF98-088	Low Power Radiation-Hardened Analog Electronics
AF98-089	Long-Life, Fault Tolerant, Spacecraft Sensor Gimble/Bearing System
AF98-090	Micro-Sensors for In-Situ Rolling Element Bearing Temperature and / or Pressure Measurement
AF98-091	Thermal Management for Advanced Electronics
AF98-092	Ultra-Low-Power Semiconductor for Multi-Chip Modules
AF98-093	Advanced Thermal Control Coatings
AF98-094	Spacecraft Thermal Management
AF98-095	Vibration Isolation of Launch Vehicle Payloads
AF98-096	Maintaining Cleanliness of Large, Previously Cleaned, Components During Transportation

PHILLIPS LABORATORY - ADV. WEAPONS & SURV. KIRTLAND AFB NM

AF98-097	Electromagnetic Effects, Measurements, Protection, Sources, & Satellite Protection
AF98-098	Vacuum High-Power Microwave Load
AF98-099	High power Triggered Gas Switches
AF98-100	Neutralization of Chemical / Biological Agents
AF98-101	High Power Microwave Antennas and Mode Converters
AF98-102	High Power Solid State Switches
AF98-103	Neutralization of Airborne Chemicals
AF98-104	Weapons Detection
AF98-105	Hidden Object Identification

ROME LABORATORY, ROME NY

AF98-106	Space Communications Protocol Standards (SCPS) Integration into Satellite Operations Infrastructure
AF98-107	Affordable Array Antenna for Multiple Satellite Links
AF98-108	Military Space-Ground Link Interface Unit
AF98-109	Jammer & Spoofer Detection, Direction Finding, & Location Technology
AF98-111	Data Link Control Protocol
AF98-112	Low Interference Cross-Polarization Phased Array Radiating Elements
AF98-114	Application of Nonlinear Dynamics (Chaos) to Space Communications
AF98-115	On-the-Fly, Loseless Data Compression
AF98-116	Security & Robustness Enhancement Techniques for Commercial Systems
AF98-117	Simulation Toolkits for Switching Satellite Communications Systems
AF98-118	WWW Management Tools for Satellite Communications Management
AF98-119	Digital Beamforming Development
AF98-120	Digitally Adaptive Nulling Algorithm Development
AF98-121	EHF / SHF / Ka Communications Link Attenuation & Availability Model
AF98-122	Mutual Input / Output Photonic Sensors
AF98-124	Generic Intelligent User Interface Agent
AF98-125	Object Oriented Design of Legacy Systems
AF98-126	Advanced Distributed C4I Simulation Capabilities
AF98-127	Innovative C4I Technologies
AF98-128	Mobile, Adaptive Knowledge Base Decision Agents
AF98-130	Dynamic Data Mining
AF98-131	Adaptive Data Fusion Technology
AF98-132	Automatic Video Scene Model Generation
AF98-133	Cross-Platform Collaboration
AF98-134	Defensive Information Warfare Technology
AF98-135	Adaptive Signal Processing Algorithm Development for Airborne Early Warning Radar
AF98-136	Advanced Techniques for Video Indexing & Retrieval
AF98-137	Optical Memories
AF98-138	Electro-optical Data Transport for Optical Memories
AF98-139	Monitoring & Management of Distributed Information Infrastructure
AF98-140	Advanced Tools for Information Warfare
AF98-141	Synthetic Aperture Radar (SAR) Enhancing Techniques
AF98-142	Innovative Special Operations Technologies
AF98-144	Optical Backplane Interconnects for High Performance Computing

WRIGHT LABORATORY - AVIONICS DIRECTORATE, WRIGHT PATTERSON AFB OH

AF98-145	Synthetic Data Prediction & Validation Techniques for Automatic Target Recognition
AF98-146	Design Automation for Analog & Mixed-Signal Circuits
AF98-147	Support Technologies for Military Essential Multichip Modules
AF98-148	Electronic Countermeasures (ECM) & Electronic Counter-Countermeasures (ECCM) Analysis
AF98-149	Cost Estimation for Revolutionary Avionics Payloads for Uninhabited Air Vehicles
AF98-150	Multi-Spectral, Multi-Functional Laser Sources

AF98-151	Multi-Aperture Tracking & Designation System
AF98-152	Avionics Collaborative Engineering
AF98-153	Electronic Protection (EP) for Electronically Steered Arrays
AF98-154	Innovative Microelectronics Device Development for Military Essential Systems
AF98-155	Feature-Based Automatic Target Recognition
AF98-156	Solid State Radio Frequency (RF) Electronics Applied Research
AF98-157	Frequency Hopping (FH) Signal Prediction & Countermeasures
AF98-158	Combat Identification (CID) Technologies
AF98-159	Unique Sensor Concepts for Infrared Multispectral Imaging
AF98-160	Precise Image Calibration & Alignment (PICA)
AF98-161	Very High Speed Integrated Circuit Hardware Description Language (VHDL) Models(Backplane)
AF98-162	Design Technologies for Re-engineering & Redesign of Legacy Systems
AF98-163	Hardware / Software Co-design / Co-simulation, Co-specification, Co-synthesis
AF98-164	Digital Receivers for Global Positioning Systems
AF98-165	Unified Evidence Accrual for Data-Fusion
AF98-166	Very High Speed Integrated Circuit HardwareDescription Language (VHDL) Models (Network Open)
AF98-167	Turbo Codes for Data Links
AF98-168	Innovative Electro-Optic Device Technology for Military Unique Devices
AF98-169	Solid State Laser Projector (SSLP)
AF98-170	True 3-D Tactical Threat & Command / Control Display
AF98-171	New False Alarm Reduction Techniques for Infrared Missile Warning Systems

WRIGHT LABORATORY - FLIGHT DYNAMICS, WRIGHT-PATTERSON AFB OH

AF98-172	Enabling Criteria Development for Utilized Composite Structures
AF98-173	Hybrid Convection / Radiation Heat Rejection Technologies
AF98-174	Aeromechanics for Future Aircraft Technology Enhancement
AF98-175	Flight Control Technology
AF98-176	Aging Aircraft Support / Sustainment Reduction
AF98-177	Automated Bird Detection & Warning System for Airports
AF98-178	Active Flow Control
AF98-179	Simplified Manual Flight Control
AF98-180	Adaptive Wing Structures for Enhanced Aircraft Maneuver
AF98-181	Advanced Fly-By-Light Control of Electric Flight Control Actuation
AF98-182	Aerodynamic Drag Reduction
AF98-183	Flight Simulation Technology
AF98-184	Innovative Damping Concepts for Extreme Environments
AF98-185	Coherent / Incoherent Radiation Fire Suppression Technologies
AF98-186	Craze Resistant & Delamination Resist Transparencies with Buried Metallic Films

WRIGHT LABORATORY - MATERIALS, WRIGHT-PATTERSON AFB OH

AF98-187	Discontinuously Reinforced Metal Matrix Composite Materials for Advanced Air Force System
AF98-188	Epitaxial Growth of Silicon Carbide
AF98-189	Life Prediction of Advanced Materials in Aggressive Environments
AF98-190	Integrated Substrate & Thin-Film Design Methods
AF98-191	Near Real Time Monitoring of Thin-Film Materials & their Interfaces
AF98-192	Advanced Coating Systems
AF98-193	Matrix Materials for High Performance, High Adhesion Sealants & Gap Treatments
AF98-194	Ballistic Damage Tolerant Composite Materials for Unhabited Aerial Structural Applications
AF98-195	Improved Film Adhesive for On-Aircraft Bonded Repairs
AF98-196	High Temperature, Long-Service-Life Fuel Cell Bladder Materials
AF98-197	High Temperature Superconducting Films
AF98-198	Materials & Processes for Development of Supermolecular Architectures for Optical Applications
AF98-199	Frequency Conversion & Electro-Optical Materials
AF98-200	Methods to Measure Corrosion Kinetics in Aging Aircraft Aluminum
AF98-201	High Temperature Structural Materials for Advanced Air Force Systems

AF98-202	Novel Nondestructive Evaluation Technology for Aerospace Components
AF98-203	Oxidation Resistant Materials & Light Weight Tankage Materials for Military Space Plane Applications
AF98-204	Micromechanical Failure Prediction Using Heterogeneous Elasticity
AF98-205	Processing of Functionally-Graded Thermoplastics for Process-Efficient Rocket Motors

WRIGHT LABORATORY - ARMAMENT, EGLIN AFB FL

AF98-206	Munition Flight Mechanics Research
AF98-207	Active Vortex Control
AF98-208	Neural Network Based Aerodynamic Flight Simulation
AF98-209	Terra Navigation Penetrator
AF98-210	Aeroshaping Optimization Using Computational Fluid Dynamics
AF98-211	Guidance Research
AF98-212	Biological Paradigms for Autonomous Seekers
AF98-213	Global Target-Finding Through Intelligent Agent Scene Inference
AF98-214	Real-Time Rendering of Translucent Volumetric Objects
AF98-215	Compression Algorithm Designed for Target Detection
AF98-216	Compact High-Power Laser
AF98-217	Near Photographic Quality Passive Millimeter Wave Imaging
AF98-218	Ordnance Research
AF98-219	Media Detection & Identification Sensor
AF98-220	Shock Hardened Timer Base Research
AF98-221	Nano-particles: Novel Coating Methods & Modeling Reactions with Liquid/Solid Oxidizers
AF98-222	Modeling & Data Acquisition Research
AF98-223	Ground-Fixed Target Vulnerability Technology
AF98-224	High Repetition Rate / Long Pulse Photographic Laser Source
AF98-225	Imaging Analysis System for Dynamic Events

WRIGHT LABORATORY - MANUFACTURING TECH, WRIGHT-PATTERSON AFB OH

AF98-226	Predictive Activity-based Cost Modeling Agent Network
AF98-227	Solid Freeform Fabrication
AF98-228	Remote Field Eddy Current Techniques for Structural Damage Detection
AF98-229	Affordable Plastic Patterns for Precision Investment Casting
AF98-230	STEP (Standard for the Exchange of Product data / International Standards Organization
AF98-231	Weapon System Integrated Cost Model

WRIGHT LABORATORY - AERO PROPULSION & POWER, WRIGHT PATTERSON AFB OH

AF98-232	Aero Propulsion & Power Technology
AF98-233	Power Technologies for Ground Support
AF98-234	Power Technologies for Unmanned Aerial Vehicles
AF98-235	High Mach, Air Breathing, Storable-Fuel Engine Technology
AF98-236	Reduced Chemical Kinetic Models for Practical Fuels
AF98-237	Advanced Multidimensional Imaging Technologies for Combustion Diagnostics Applications
AF98-238	Combustor / Heat Exchanger Innovative Technology Research
AF98-239	Power Generation & Thermal Management
AF98-240	Advanced Instrumentation & Simulation Technology for Ramjet / Scramjet Combustors
AF98-241	Auxiliary Bearings for Magnetically Supported Rotors
AF98-242	Aircraft Turbine Component Technology-Aerodynamics & Cooling
AF98-243	High Heat Sink Jet Fuels, Additives & Test Methods
AF98-244	Advance (High Temperature of Cryogenics) Dielectrics & Capacitors
AF98-245	Real-Time Turbine Engine Fault Detection / Condition Monitoring System
AF98-246	Probabilistic Diagnostic & Prognostic System for Gas Turbine Engines

AF98-247	Aircraft Power Electronic Components
AF98-248	Advanced Sensors for Supercritical Engine Fuel Systems
AF98-249	Advanced Compression System Concepts
AF98-250	Advanced Development of High Cycle Fatigue Mgmt Tools

TECHNOLOGY TRANSITION OFFICE, WRIGHT-PATTERSON AFB OH
SAN ANTONIO ALC - Kelly AFB TX

AF98-251	Square Canopy for ACES II Ejection Seat
AF98-252	AI-ESTATE
AF98-253	ABBETT

OKLAHOMA CITY ALC - TINKER AFB OK

AF98-254	Ergonomic Assist Device for Water Blast Gun Manipulation
AF98-255	Turbine Oil Condition Monitoring by Raman Spectrometry
AF98-256	Development of Sensor for Monitoring Aircraft Batteries

SACRAMENTO ALC - MCCLELLAN AFB CA

AF98-257	Robust Batteryless Power Backup for Critical Power Applications
AF98-258	In-Situ Remediation of Polychlorinated Biphenyls (PCB) in Soils
AF98-259	Composite Repair / Manufacture Techniques Utilizing Ultraviolet (UV) Hardenable Resins

OGDEN ALC - HILL AFB UT

AF98-260	Fault Set for Bussed Components
AF98-261	Multiplexed, Real-Time Opacity Monitor
AF98-262	Statistical Control Process Application to Test Failure Information

WARNER ROBINS ALC - ROBINS AFB GA

AF98-263	NDI of Cracks,Corrosion,etc. in Second and Third Layer Materials Fastener Holes
AF98-264	Surface Mapping System for Complex Weapon System Components
AF98-265	Advanced Corrosion Life Prediction Tool
AF98-266	Conversion Process for Legacy Stable Based Printed Circuit Board Artwork
AF98-267	Global Positioning System (GPS) Satellite 3-D Visualization and Blanketing Tool
AF98-268	Environmentally Compliant Touch-up Process for Two-Component Paints
AF98-269	Next Generation Lubricant for Weapon Systems
AF98-270	Portable,Non-Damaging Depaint System for Removing Coating from Small Areas

AIR FORCE DEVELOPMENT TEST CENTER, EGLIN AFB FL

AF98-271	Subminiature Telemetry Instrumentation
AF98-273	Multiple Direction Blast Pressure Measurement
AF98-274	High-Level Electromagnetic Field Generation Capability
AF98-275	Advanced PC-Based Telemetry Processing and Display System
AF98-277	Weapon Lethality Assessment Instrumentation Technology

46th TEST GROUP, HOLLOMAN AFB NM

AF98-278	Tightly Coupled GPS / INS Laboratory Test Capability
AF98-279	Adaptive Antenna Array for RCS Measurements
AF98-280	Reduced RCS Modification to T-38 Aircraft

AIR FORCE FLIGHT TEST CENTER, EDWARDS AFB CA

AF98-281	Bandwidth Efficient Telemetry Access (BETA)
AF98-282	Range Atmospheric Visibility Monitoring (RAVM)
AF98-283	Modular Affordable Global Position System / Inertial Navigation
AF98-284	High Performance Digital Modulation for Air-to Ground Telemetry
AF98-285	Common Terrain Database and Real Time Terrain Database Server
AF98-286	Radio Frequency (RF) Plane Wave Generator
AF98-287	Characterization of Ozone Transport into Eastern Kern County

ARNOLD ENGINEERING DEVELOPMENT CENTER, ARNOLD AFS TN

AF98-288	Pressure-Sensitive Paint (PSP) for Broad Spectrum of Application
AF98-289	Active Pixel Sensor Camera for Scientific Imaging
AF98-290	Model Attitude and Deformation Measurement System
AF98-291	Accurate,Non-Intrusive,Global or Profile Measurement Device for one or more Flowing-Gas
AF98-292	Atomic Oxygen (AO) Beam Generator
AF98-293	Skin-Friction Measuring System for Large Wind Tunnels
AF98-294	Low Cost Conformal Window Optics for Wind Tunnel & Test Cell Optical Diagnostics
AF98-295	Advanced Short, Mid and Long Wavelength Infrared Detector Material

SACRAMENTO ALC - MCCLELLAN AFB CA

AF98-296	Infrared Imaging-Phased Array Radar

AIR FORCE FLIGHT TEST CENTER, EDWARDS AFB CA

AF98-297	Multi-Color Filter Development for Hardware-in-the-Loop Facility

AIR FORCE DEVELOPMENT TEST CENTER, EGLIN AFB FL

AF98-298	Rapid Generation for Advanced Terrain Visualization

U.S. AIR FORCE

FY1998 TOPIC DESCRIPTIONS

AF98-001 TITLE: Human Systems/Subsystems Research

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: Proposers may submit ideas to enhance human performance as an integral part of Air Force systems and operations. Five directorates perform a full spectrum of basic and applied research including exploratory and advanced development: (Specify subtopic by letter).

a. The Human Resources Directorate conducts research in manpower and personnel, force management, training systems (including pilot training) and logistics/information technologies. The objective is to improve operational readiness and control costs by developing technologies for more effective selection, assignment, training and retention of a high-quality military force.

b. The Crew Systems Directorate conducts research and development (R&D) to improve human performance, protection, and survivability in operational environments. R&D is conducted to: determine human responses to operational stressors, such as noise, impact, vibration, hostile fire, sustained acceleration, spatial disorientation, altitude, workload, and sustained operations; define human-centered design criteria and concepts for personal protection equipment and workstations; and optimize human-machine integration including visual/auditory displays and crew communication.

c. The Aerospace Medicine Directorate addresses the medical selection, protection and enhancement of humans in Air Force systems and operations. Mission related research and specialized operational support are conducted in aeromedical consultation, epidemiology, drug testing, hyperbaric medicine, and dental devices. Clinical sciences research is conducted to develop standards for aviator selection and retention.

d. The Occupational and Environmental Health Directorate assesses risks to personnel from hazardous materials, toxicology, noise, electromagnetic radiation, (Radio Frequency and Laser) and occupational processes and conducts research to reduce those risks. The goals are to mitigate impacts on health and to enhance the scientific understanding of the underlying biological mechanisms.

e. The Environics Directorate conducts in-house research and manages out-sourced contracted research on innovative technologies to fulfill Air Force requirements for site cleanup and environmental compliance. Site cleanup research emphasizes fuels and solvents. Environmental compliance emphasizes fuels, solvents, and other aerospace materials. Specific areas of research include the behavior, transport, and ultimate fate of chemicals in air, soil, or water; advanced contaminant characterization and pollutant monitoring; contamination cleanup technologies through control, conversion, or destruction using biological, physical, and chemical processes; and hazardous waste minimization. The goal is to find the most efficient, economical, and effective answers to eliminate, substantially reduce, or mitigate environmental consequences of Air Force operations.

REFERENCES:

Armstrong Laboratory , Organization Brochure, Unclassified. Public Release. Copies may be obtained from the Defense Technical Information Center (DTIC), Telephone Number 1-800-363-7247.

AF98-002 TITLE: Human-Centered Technologies for Information Superiority

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop assessment techniques and enhancement, hardening, and/or remediation strategies to improve the performance of the human decision maker in the context of information warfare.

DESCRIPTION: The Air Force has established Information Superiority as one of its six core competencies. Fundamentally, Information Superiority is achieved when friendly decision makers (commanders, intelligence analysts, etc.) can reliably execute faster, more flexible, and/or more thoroughly evaluated decisions than can an adversary. Innovative approaches are sought in the areas of personnel selection and training, human system interface design technology, modeling of human performance, and logistics support. Technologies of interest are those which can be expected to improve the speed, appropriateness, and/or richness of friendly force intelligence exploitation, command and control, battle space awareness, battle management and other components of

operational Information Superiority.

PHASE I: Identify human-centered technologies which may reasonably be expected to contribute to achieving and maintaining Information Superiority in the face of a full range of adversarial capabilities to wage information warfare. The deliverable will be a proof-of-principal demonstration, including a quantitative performance analysis.

PHASE II: Optimize the technology(s) demonstrated in Phase I and design, produce and deliver a functional prototype for Air Force evaluation and testing.

PHASE III DUAL USE APPLICATIONS: Enhancements to training capabilities will have direct application in the commercial market, especially as employee reductions and corporate restructuring continue. Innovations in interface design technology and performance aiding will have wide application in the entertainment, services, strategic planning, crisis management, and process control/facility management industries.

REFERENCES:

1. Whitaker & Kuperman (1996), Cognitive Engineering for Information Dominance: A Human Factors Perspective, AL/CF-TR-1996-0159, ADA 323369, Armstrong Laboratory, Wright-Patterson Air Force Base, Ohio.
2. DiNardo & Hughes (1995), Some Cautionary Thoughts on Information Warfare, Airpower Journal, Winter 1995, 1-10.
3. Johnson & Libicki (eds.) (1995), Dominant Battlespace Knowledge: The Winning Edge, Washington DC: National Defense University.

AF98-003 TITLE: New Emission Control Technology for Hydrazine Fuels

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Development of an environmentally compliant and pollution preventing system for treating gases mixed with hydrazine, MMH or UDMH vapors.

DESCRIPTION: Many missiles, spacecraft and space launch vehicles utilize storable propellants to permit ease of storage, handling and long on-orbit life. Those commonly used for fuels are hydrazine, monomethyl hydrazine (MMH) and unsymmetrical dimethyl hydrazine (UDMH) or a blend of these fuels. The oxidizer of choice is nitrogen tetroxide (N204 or NT0). These chemicals are highly energetic and consequently are very hazardous. The process of storage and transfer requires that storage vessels and transfer lines be pressurized and purged with inert gas, usually nitrogen. It is necessary that this gas be decontaminated to a level which will not cause violation of federal, state and local air quality restrictions. In the past, this has been accomplished using either burners or scrubbers. While burners will generally reduce the toxic levels adequately, they suffer from emission levels of oxides of nitrogen (NOx) and other typical hydrocarbon combustion products. The current trend has been toward utilizing scrubbers which remove the contaminants by either dissolving them or reacting them in a "liquor." In most cases, this liquor must then be disposed of as a hazardous waste. This is not in consonance with the national stress on pollution prevention - changing processes such that hazardous wastes are not created, rather than deal with treating them at a later stage. Current hydrazine scrubber design provides excellent removal by simply scrubbing with water - even in view of the new 10 ppb hydrazine limit. However, the hydrazine-water solution is again a hazardous material which must be disposed of properly. The objective of this topic is the development of a variation on the fuel scrubber technology which will combine the proven water scrubber with a proven method for reacting the dissolved hydrazines to a safe product. One possible approach to consider would be ozonation plus ultraviolet radiation to further decompose organic byproducts. This must be accomplished in one continuous process - otherwise the user must be licensed as a Treatment, Storage and Disposal (TSD) facility under the Resource Conservation Recovery Act (RCRA) - an expensive and painful process.

PHASE I: Perform theoretical analyses of the chemical dynamics involved in the proposal process to determine decontamination feasibility over the range of 10 to 200 standard cubic feet per minute (SCFM) vapor flow containing UDMH vapor content up to 40 lb/min.(UDMH being the most stressing requirement). Perform pilot scale demonstration of the continuous decontamination process.

PHASE II: Design and construct a full scale operational prototype, preferably as a modification of an existing water-based scrubber. Conduct full scale tests with all three propellants to demonstrate its capability to perform to mutually agreed requirements.

PHASE III DUAL USE APPLICATIONS: This technology has great potential for use in treating many vapors of organic compounds controlled under the Hazardous Air Pollutants in the Clean Air Act. Also, the ability to handle hydrazine vapors in such a manner is of great interest to commercial launch vehicles as well as in the maintenance and operation of hydrazine-fueled auxliary propulsion units (APUs) on advanced aircraft.

REFERENCES: Evaluation of U.S. Air Force Hydrazine Waste Water Treatment System, Agthe, R.E, D. Johnson and I. Smith, Test Report, NASA, TR-628-001, Johnson Space Center, White Sands Test Facility, 1992.

AF98-004 TITLE: Conversion Coating Process for Large Area Aluminum Alloy Components

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop an environmentally acceptable, cost effective, large surface area, corrosion prevention process for aluminum alloys.

DESCRIPTION: A high priority commercial/military need exists for a corrosion prevention coating process for large area aluminum alloy structures/components. The hexavalent chromium salts in the current aluminum alloy chromium conversion coating process creates waste that is hazardous and carcinogenic. Disposal of this waste is extremely expensive. Also, chromium is on the Environmental Protection Agency (EPA) Industrial Toxic Chemicals List and is currently highly regulated by the Aerospace Manufacturing and Rework NESHAP (National Emission Standards for Hazardous Air Pollutants). Current alternative processes based on ZrO, MnO4, TiO, CoO, etc. are applicable to coating of small parts by tank immersion but are not applicable to the coating of large parts which cannot be immersed, nor to field repair. The need is to treat large aluminum structures (up to approx. 600 to 1000 square feet) utilizing nonelectrolytic brush, spray or wipe application at ambient temperature, with subsequent air drying. The resulting coating must be capable of rework, be uniform, continuous, smooth and free from powder or loose coating, provide acceptable corrosion resistance and paint adhesion properties approximately equivalent to the chromate coatings previously covered by Mil Standard MIL-C-5541E. Applicability to 2000 series aluminum alloys is a priority.

PHASE I: Effort will include analysis/development/selection of the most promising, environmentally acceptable, non-chromate coating processes together with corrosion resistant testing of selected coatings on 2000 series aluminum alloys.

PHASE II: Selection, optimization and demonstration of the best coating on the basis of acceptability of coating process, cost, performance on large 2000 series aluminum alloy panels. Test panel tests will be performed wherein the coating will be applied by means of existing equipment that will be made available by the Air Force.

PHASE III DUAL USE APPLICATIONS: An environmentally acceptable conversion coating for corrosion control of large aluminum surfaces which is cost effective and easily applied to large surfaces under factory and non-factory conditions. The technology is applicable to all uses of aluminum alloys, whether for aerospace vehicles, military, architectural or consumer product applications.

REFERENCES:
H. A. Katzman and G. M. Malouf, Corrosion-Protective Chromate Coatings on Aluminum, Application of Surface Science, Vol. 2, 416-432, 1979.
R. W. Hinton, Corrosion Prevention and Chromates, The End of an Era? METAL FINISHING, Vol. 89, No. 9, 55-61, 1991.
G. W. Brown, et al., The Morphology, Structure and Mechanism of Growth of Chemical Conversion Coatings on Aluminum, CORROSION SCIENCE, Vol. 33, No. 9, 1371-1385, 1992.
F.Chang, M. Levy and R. Huie, Assessment of Chromate and Non-Chromate Conversion Coatings for Al Alloys Using Electrochemical Impedence Spectroscopy, Army Research Laboratory, Report No. ARL-TR-142, June 1993.
S. J. Spadafora, Non-Chromated Surface Pretreatments for Aluminum, Naval Air Warfare Center, Interim Report, Report No. NADC-92077-60, 18 August 1992.

AF98-005 TITLE: Real-Time Characterization and Monitoring of Particulate Matter (PM) Emissions

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop a compact, affordable particulate emissions monitor.

DESCRIPTION: The Air Force has an increasing need to quickly and accurately analyze the chemical constituents and size distribution of particulate emissions from Air Force operations. The Environmental Protection Agency (EPA) is in the process of establishing new standards for particulate matter, and the proposed standards will likely place greater restrictions on particulates with diameters less than 2.5 micrometers (currently 10 micrometers as described in the Code of Federal Regulations 40:50), creating a requirement to monitor particulate emissions of this nature. A number of Department of Defense (DOD) operations produce significant amounts of particulate matter emissions which are largely uncharacterized, including aircraft operations, jet engine testing

and aircraft painting/depainting operations, which will suffer operational restrictions when the new standards are promulgated. The current measurement techniques involve field sampling followed by laboratory analysis, which are time consuming, labor intensive and costly. The purpose of this effort is to develop an on-site or remote, real-time in situ measurement technique to determine the size, size distribution, mass and chemical composition of the particulate matter. Optical based instruments and techniques that allow on site, continuous measurements without sampling are especially desirable. Only direct measurement techniques and submittals which include the basic planned strategy for taking the concept from development through commercialization of the final product will be considered.

PHASE I: Perform laboratory experiments that provide representative data on sample rate, specificity, spacial resolution, and sensitivity. The analysis of the data should include comparison with actual data gathered by current practices. Conceptual design work will also be performed. A proof-of-concept demonstration with an engineering model at an Air Force site is strongly desired. A competent technical report to include plans for experimental development in Phase II will be produced.

PHASE II: Perform extensive bench-scale testing, followed by field testing at Air Force designated sites. The engineering model shall be delivered to the Air Force for an in-depth evaluation of its potential along with a competent technical report documenting the completed work. Benefits to be gained from the use of the instrument will be quantitatively established for different potential applications to prepare for commercial development of the system. A well-defined commercialization plan should be included.

PHASE III DUAL USE APPLICATIONS: The product would reduce the size, cost, and complexity of particulate matter monitoring without the need for discrete sampling. Potential markets include the aircraft industry, automobile industry and other commercial manufacturers who must monitor their emissions to comply with the new EPA standards.

REFERENCES:

1. Willeke, Klaus and Baron, Paul A., Aerosol Measurement: Principles, Techniques, and Applications, Van Nostrand Reinhold, New York, 1993.

2. Chow, Judith C., Measurement Methods to Determine Compliance with Ambient Air Quality Standards for Suspended Particles, ISSN 1047-3289, Journal of the Air & Waste Management Association, May 1995.

3. Code of Federal Regulations, Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method), 40 CFR Part 50, Appendix B, U.S. Government Printing Office, Washington, DC, July 1994.

4. Federal Register, National Ambient Air Quality Standards for Particulate Matter, 40 CFR 50, Proposed Rule, Federal Register Cite 61 FR 65638, December 13, 1996.

AF98-006 TITLE: Hydrocarbon and Volatile Organic Compound (VOC) Oxidation Catalysis at Standard Temperature and Pressure

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop an environmentally-sound system for decontaminating exhaust ventilation air containing traces of fuel and solvent vapors.

DESCRIPTION: Fuel- or solvent-intensive operations, (such as maintenance of aircraft fuel tanks, vapor degreasing of metal components, and spray painting of aircraft) are typically conducted in ventilated workspaces. Air used to ventilate these spaces during performance of such operations is tainted with vapors that require decontamination before the air can be released or reused. Conventional oxidation methods occur at elevated temperatures, which requires that energy be supplied to raise the exhaust stream to the ignition temperature of the respective oxidation process. At the concentrations of contaminants normally encountered in exhausts from workspaces, the cost to apply high-temperature oxidation methods is often unacceptably high. Both energy and money would be saved by an oxidation process that occurred at the temperature of the process exhaust, and, if heating, cooling, or humidity control is needed for the process, further economy could be realized either by direct reuse of the decontaminated air stream in the process by recovering heat from the treated exhaust by thermal exchange with incoming fresh air. This project is to develop one or more catalytic materials or composites that can demonstrate complete oxidation of one or more representative hydrocarbons or oxygenated hydrocarbons in room air for an indefinite period of time at a temperature below 100 degrees Fahrenheit, and to incorporate the[se] catalyst[s] into a practical decontamination technology for large-volume ventilation exhausts contaminated by fuels and solvents at high dilution.

PHASE I: Prepare candidate catalyst formulations and evaluate over several hours the ability of each to oxidize one or more hydrocarbons or oxygenated hydrocarbons at low [~10 ppm] concentration in room air at 100 degrees Fahrenheit. For those formulations that accomplish greater than 60 percent destruction of the organic[s] at space volumes of 100 min-1 and that retain greater than 90 percent of their initial reactivity at the conclusion of the test, analyze the feasibility of applying the material in

stationary beds to decontaminate exhaust streams of 5|500kcfm containing 2|200 ppm toluene.

PHASE II: Extend testing to determine minimum effective temperature, rate of inactivation at temperatures from 60 degrees Fahrenheit up to a point that 1/2 falls below 72 hours, and inhibition or activation by CO_2, H_2O, NO, SO_2, and HCl. Nonhazardous additives and adjustments of the formulation are allowed as enhancements to the properties of the catalyst[s]. Design and construct a pilot-scale treatment system which will be tested on a side stream drawn from the exhaust from an industrial process at a military facility to be selected by the laboratory technical monitor. Conduct a treatment test at the selected installation; analyze the performance of the treatment system and specify modifications necessary to apply it at full scale to related process exhausts; estimate the balanced life-cycle cost to apply the technology demonstrated as a full-scale control device to the actual process exhaust on which the test was performed.

PHASE III DUAL USE APPLICATIONS: This technology would revolutionize the economics of indoor-air cleaning and VOC control, might passively decontaminate outdoor air, and might also protect personnel against chemical and biological agents.

REFERENCES:

1. Hoflund, G. B., et al, Au/MnOx Catalytic Performance Characteristics for Low-Temperature Carbon Monoxide Oxidation, Applied Catalysis B, 6[2], 117126 (1995).
2. Hoflund, G. B. et al., Langmuir, Effect of CO2 on Performance of AuMnOx Low Temperature CO Oxidation Catalysts, 11[9], 3431-3434 (1995).
3. Hoflund, G. B., et al, Influence of Promoters on the Performance of AuMnOx and Pt/SnOx/SiO2 Low-Temperature CO Oxidation Catalysts, Reaction Kinetics and Catalysis Letters, 58[1], 1926 (1996).

AF98-007 TITLE: Test Method to Determine Presence of Subsurface Bacteria Capable of Dehalorespiration

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop a technology for detection and quantitation of microbial systems in the subsurface able to catalyze sustained dehalorespiration.

DESCRIPTION: Recent advancements in the understanding of the anaerobic degradation of chlorinated ethenes indicate that the contaminants can serve either as an electron donor or be degraded through a cometabolic process. To predict the natural attenuation of the chlorinated compounds or enhance their anaerobic degradation via the addition of a carbon source requires understanding of the capabilities of the native consortia. The presence of bacteria able to carry out sustained dehalorespiration is essential to the success of natural attenuation of chlorinated ethenes. Such bacteria are either not present or not active in some subsurface systems. A strategy or technique for detection of the responsible organisms and accurate prediction of their activity in situ is required before natural attenuation can be predicted reliably. At present, extensive testing with microcosms or evaluation of hydrogeological evidence of natural attenuation is required to provide evidence of dehalorespiration. Accurate detection of the responsible organisms or their activity would allow for the more predictable application of natural attenuation.

PHASE I: Develop a test method to determine the presence or absence of specific dechlorinating populations that are capable of catalyzing the dehalorespiration of chlorinated ethenes. The test method should utilize aquifer material from a contaminated site.

PHASE II: The test method will be applied to five field sites where enhanced dechlorination or natural attenuation is being applied for chlorinated ethenes. A currently funded Environmental Security Technology Certification Program (ESTCP) effort is investigating enhanced in situ dechlorination at five DoD sites--therefore, contaminated aquifer material will be readily available. Also, results from this new test method will be compared to more extensive and expensive bench- and field-scale efforts at these sites.

PHASE III DUAL USE APPLICATIONS: Chlorinated ethene soil and groundwater contamination is one of the biggest problems faced by both the DoD and private industry. The DoD used large volumes of perchloroethylene (PCE) and trichloroethylene (TCE) as degreasing solvents and the private sector, most notably dry cleaners, still utilizes solvents such as PCE. This test method has the potential to be patented and should be marketed to site clean-up companies and contaminated site-responsible parties to assist with their remediation feasibility studies. A validated test method as described above will be invaluable to those making decisions regarding site cleanup. This tool will help more accurately predict the efficacy of natural attenuation or enhanced anaerobic dechlorination. Therefore the selection of ineffective treatment schemes will be minimized and clean-up costs will be reduced.

REFERENCES: Vogel, Catherine M., et al., "Symposium on Natural Attenuation of Chlorinated Organics in Groundwater," AL/EQ-TR-1996-0048, 1996. ADA 3191114.

AF98-008 TITLE: Advanced Analytic Sonic Boom Underwater Propagation Analysis

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop improved analytic sonic boom penetration modeling capabilities for choppy ocean and bubble entrainment effects.

DESCRIPTION: Flight corridors for Air Force operations involving subsonic and supersonic aircraft and launch vehicles often lie over ocean surfaces near shore. Significant populations of marine life, specifically marine mammals, inhabit the surface and depths of these water areas. Environmental compliance with the National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA) and the Administrative Policy Act requires the Air Force to use predictive noise tools to assess impacts to humans, animals, and structures and to address noise issues of the National Marine Fisheries Service and the National Fish and Wildlife Service. Changes requiring noise assessments include new vehicle types, reassignment of units to new locations, new training routes or flight trajectories, special uses of weapons ranges, and weather effects. In order to further compliance with these environmental issues, sonic booms and focused booms (shaped and/or super booms) penetrating choppy or bubbly water are areas where the Air Force seeks better noise modeling capabilities, although proposals are invited on all aspects of noise modeling, including better propagation algorithms, noise contouring, and noise measurement procedures. The research and development efforts needed to predict and assess the effects of aircraft and launch vehicle noise will result in technical capabilities that can be used by acoustical and contractor firms that support various federal agencies required to address environmental noise issues involving coastlines or large lakes.

PHASE I: Provide an analytic approach and demonstration of the feasibility of the analytic approach, through limited experimental verification, demonstrating the proposed tool or model, specifically for the shaped or super boom case penetrating choppy and/or bubbly water, and for other cases of flight.

PHASE II: Phase II will result in fully developed, user friendly, experimentally verified, computer programs or other tools for modeling or measurement of noise that can be used in commercial as well as military compliance needs.

PHASE III DUAL USE APPLICATIONS: Agencies such as the Army and Navy, Federal Aviation Administration, National Aeronautics and Space Administration, Department of Transportation, and National Park Service all use commercial acoustic firms to perform analyses which could use the products of this research and development. Contractors for state and local agencies, such as land-zoning boards, could utilize such new resources.

REFERENCES:
1. Plotkin, K.J., PCBoom3 Sonic Boom Prediction Model-Version 1.0c, Wyle Research Report WR95-22c, May 1996.
2. Sparrow, V. W. The effect of supersonic aircraft speed on the penetration of sonic boom noise into the ocean, Journal of the Acoustical Society of America, Vol. 97, No. 1, January 1995, pp. 159-162.
3. Cheng, H. K., et al., Sonic Boom Propagation and Its Submarine Impact, AIAA No. 96-0755, 34th Aerospace Sciences Meeting, Reno, NV, Jan. 1996
4. Sparrow, V. and Ferguson, T., Penetration of Shaped Sonic Boom Noise into a Flat Ocean, AIAA No. 97-0486, 35th Aerospace Sciences Meeting, Reno, NV. Jan. 1997.
5. Haber, J., et al. Effects of Aircraft Noise and Sonic Booms on Structures: An Assessment of the Current State-of-Knowledge, HSD-TR-89-002, Aug. 1988. (AD A213 919)

AF98-009 TITLE: Automated Cell Culturing and Exposure Chamber

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Design an automated self-contained cell culturing, dosing and harvesting chamber capable of diluting cells to proper density, plating cells, changing media, dosing cells and harvesting cells under aseptic conditions.

DESCRIPTION: The elimination of human error in experimental design and the need to limit human exposure to xenobiotics suggest automation of in-vitro experimental procedures in a closed environment. In-vitro cell cultures are a primary means to establish the toxic effect of xenobiotics on living systems. However, the maintenance of these cultures, dosing of cultures with xenobiotics and the eventual collecting of treated cells is a labor intensive process. Automation of this process would both eliminate the aspect of human error in experimental analysis and provide 24-hour testing of hazardous compounds. An added benefit of this project is a reduction in manpower required for the toxicological analysis of chemicals. Personnel working in a cell culture laboratory currently

perform the following tasks during the course of experiments: move and aseptically remove the lids from cell culture plates; maintain aseptic conditions at all times (bacteria and fungus free); maintain a homogeneous suspension of cells; remove and analyze aliquots for yield and viability; seed the cells at a desired density; change media; dose cells from a stock dosing solution to achieve serial dilutions; dose cells with labeled probes (fluorescence and/or radioactive) for analysis; wash cells in plates and collect the effluent for waste disposal; remove cells from plates for follow-on analysis; remove and store plated cells aseptically in an incubator (standard cell culture incubator system with temperature, moisture and air intake control); handle hundreds of standard 96, 24, 12 or 6 well tissue culture plates; work with multiple cell types and multiple stock solutions for dosing; use multiple stock solutions with labeled probes and multiple washing buffers, medias and fixing solution; refrigerate and warm (4 degrees Celcius to 50 degrees Celcius) solutions and harvest specimens. While some prototype robotic systems do exist, no system capable of plating, changing media and dosing cells currently exist on the market. The challenge to produce an aseptic automated environment of this magnitude represents a medium risk. However, the current state of robotics and insertion of technology developed from the semiconductor industry which requires high quality clean room conditions should help to reduce overall program risk.

PHASE I: A prototype robotic system capable of determining cell number and viability, plating cells out at user defined density and changing media (does not have to be multiplate) plus design (based on initial proposal or amended as phase one efforts dictate), program and test schedule for phase II. The phase I design would be a robotic arm programable in x, y and z direction which could take an alliquot of cells, dilute cells to user defined plating density and pipette fixed volume into cell culture wells.

PHASE II: Full prototype capable of plating cells, changing media, dosing cells and harvesting cells. To be delivered to Armstrong Laboratory for evaluation and testing using cell lines, hepatocytes and procedures developed as part of predictive toxicology effort.

PHASE III DUAL USE APPLICATIONS: This product would be a desirable item to be used by small business, large industry and government organizations which desire to reduce manpower levels, increase reproducibility of experiments and test procedures as well as increase throughput of analysis efforts.

REFERENCES:
1. Sarraj, I.; Didelon, S.; Sabouni, A.; Donner, M. INSPEC abstract Number:C9611-338OL-001 Development of a robotic system for the monitoring of physiological parameters of cell cultures Proceedings of the IASTED International Conference, Systems and Control (1994) pages 173-176.
2. Spurbeck JL; Carson RO; Allen JE; Dewald GW Culturing and robotic harvesting of bone marrow, lymph nodes, peripheral blood, fibroblasts, and solid tumors with in situ techniques. Cancer Genet. Cytogenet. (May 1988) 32(1): 59-66.
3. Leichtfried Franz E and Pieler Christian. Incubator; Housing for sets of trays of sample containers of cell cultures that allows operation by a robotic manipulator. Patent Number US5525512 issue date 960611.

AF98-010 <u>TITLE: Intelligent Agent Technology for Searching Occupational, Personnel, and Training Data Bases</u>

CATEGORY: EXPLORATORY DEVELOPMENT; Manpower, Personnel, and Training

OBJECTIVE: Develop an intelligent web assistant for mining manpower, personnel, and training data.

DESCRIPTION: This effort will develop an intelligent search engine or web assistant for mining web data, with an emphasis on occupational, personnel, and training (OPT) data. The web assistant will match mission and job requirements with military personnel and training data. The assistant will facilitate combining occupations based on core competencies and similar work activities. It will also identify individuals qualified for work activities for which no current occupation exists. These virtual occupations are created and manned to meet unique mission and contingency requirements. In addition, the technology can be applied to situations where small production run weapon systems or subsystems are being acquired and fielded. These systems require operator and maintenance support not addressed in the current occupational structure. For example, an engineer who has designed a system can develop detailed descriptions of the activities required to operate or to maintain the system. These detailed descriptions can be provided to the web assistant so that it can identify current jobs on fielded systems that are similar in work activities. New occupations could then be structured around these activities without an existing occupational structure. However, individuals who currently work in the comparable jobs may have requisite experience in similar systems that may permit their use in support of these new systems. In these situations, the capability to match experience and competencies with system requirements is critical to mission effectiveness. An intelligent web assistant will allow the military to exploit internet resources to achieve information superiority. As part of the USAF Defense Information Architecture Common Operating Environment (DII COE), this agent will be available to all Air Force Applications. New web-based technologies (e.g., Upward Obligations Reporting System under the Global Combat Support System Architectures) will rely on the intelligent web assistant as a valuable tool. In the occupational domain, this effort will produce a cost-effective capability to systematically search occupational personnel and training databases to develop new job and training structures

to support a variety of requirements. This capability will help employers identify critical characteristics and competencies associated with work activities and then to identify individuals who have the requisite experience and competencies to perform the identified work activities. Finally, the technology to be developed is of considerable relevance to the civilian sector as a means of matching individual competencies, as described in vitae or resumes, with relevant jobs in the Department of Labor Occupational Network. The technology can also be used to identify existing jobs in the Network that are similar to new jobs being developed within an organization.

PHASE I: Perform preliminary investigation into the incorporation of natural language understanding into a web search agent that mines and reports information rather than keywords. Investigate the feasibility of integrating a multimodal interface to include natural language, graphical presentation and voice recognition. Develop search techniques and conduct a proof-of-concept assessment in two application areas: a new, low-production-run military system, and (b) a grouping of civilian occupations that are closely related to current military occupations.

PHASE II: Phase II will result in a fully developed, tested, refined, and validated intelligent web agent in both military and civilian applications. Proposals should assume that the technology will run in a Windows95TM, Pentium-based environment, but platform independent development is strongly encouraged. The intelligent web agent should operate as part of the DII COE.

PHASE III DUAL USE APPLICATIONS: Phase III Dual-use potential is significant as no quantitative search capability such as the one described herein exists. The benefits from such a capability to Government and Private Sector agencies could help organizations save considerable time and expenditures by targeting individuals to specific occupations to address specific requirements for work performance and productivity.

REFERENCES:

1. Deerwester, S., Dumais, S. T., Landauer, T. K., Furnas, G. W. and Harshman, R. A. (1990), "Indexing by latent semantic analysis." Journal of the Society for Information Science, 41(6), 391-407.

2. DII COE and GCSS: http://www.disa.mil/

3. Dumais, S. T., Furnas, G. W., Landauer, T. K. and Deerwester, S. (1988), "Using latent semantic analysis to improve information retrieval." In Proceedings of CHI '88: Conference on Human Factors in Computing, New York: ACM, 281-285.

4. Dumais, S. T. (1991), "Improving the retrieval of information from external sources." Behavior Research Methods, Instruments and Computers, 23(2), 229-236.

5. http://superbook.bellcore.com/~std/LSI.papers.html.

AF98-011 TITLE: Dynamic Force-on-Force: C3 Air/Space Operator/Manager Training

CATEGORY: EXPLORATORY DEVELOPMENT; Manpower, Personnel, and Training

OBJECTIVE: Create a multi-user simulation environment (MUSE) to train, assess, and practice team performance skills in command, control, and communication (C3).

DESCRIPTION: Training budgets in all services are undergoing massive cuts at a time when training is more essential than ever before in our history. Initial and refresher training of active duty, guard, and reserve personnel pose major problems and challenges to the services. Internet/distance learning environments have become a possibility and are being considered as a partial solution, by cutting the amount of travel that is required to support training. Training of guard and reserve personnel is essential as these groups are growing as the active military force shrinks. Major opportunities and challenges exist for training all of these groups using internet/distance learning vs classroom training or high fidelity simulators. Training in an academic environment between multiple sites in distributed C3 teams or linking high-fidelity simulators poses considerable difficulty. C3 teams have little chance to train together before operationally performing during combat contingencies. The purpose of the effort is to create a multi-user simulation environment (MUSE) to train team performance in command, control, and communication. This type of environment is to be supported through both synchronous and asynchronous communications, and can be used by military personnel to create C3 teams in a range of environments including ground, air, and space. The gaming environment allows trainers to simulate dynamic combat operations in any part of the world and train C3 personnel. The environment would involve command and control operations for air-to-air combat, air-to-ground combat and ground-to-air combat operations. The C3 teams need to be able to plan missions in short order with limited or uncertain intelligence on enemy strengths (i.e., air power, ordinance, air defense artillery, etc.), coordinate their own teams of aircraft, and direct both strategic and tactical flight operations under dynamic conditions. Communications, classifications, recognition, collaboration, team performance, and human performance are the training areas that can be well integrated into a MUSE and delivered over the internet.

PHASE I: The end product of Phase I is an intelligent instructional gaming software product, proof-of-concept,

MUSE delivered over the internet with evaluation data. (Simulations will include one to two combat environments, i.e., Middle Eastern areas.) Phase I will also result in a final technical report.

PHASE II: Produce a fully capable/completely finished software product with evaluation data. (Many different combat simulation environments, i.e., Asia, Russia, N-S Korea, Middle East, Africa, etc.) Phase II will also result in a final technical report.

PHASE III DUAL USE APPLICATIONS: This product would be fully capable for commercial sales to the public and be competitive in the software gaming industry. It could also be used by industry teaching managers critical team decision making skills. Any of the other services could use this system as it would be a viable training system for C3 regardless of the mission differences

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http://copernicus.bbn.com:70
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http://www.teleport.com/~caustic/internet.shtml

ADDITIONAL INFORMATION: Special attention should be given to the advanced technologies available for advancing the state-of-the-art of graphics and simulation in gaming environments for internet delivery (i.e., 3D, VRML, Direct 3D, OpenGL, telnet vs client program, etc.). Multi-player is an issue of concern.

AF98-012 TITLE: Distributed Methods Assessing Workgroup, and Team Effectiveness, Performance, and Readiness

CATEGORY: EXPLORATORY DEVELOPMENT; Manpower, Personnel, and Training

OBJECTIVE: Develop collaborative assessment methods and quantitative indices of individual, workgroup team performance and readiness for evaluating the impact of manpower, personnel, training, and human factors engineering.

DESCRIPTION: Recent advances in the use of the Internet for performance support demonstrates that it may be feasible to develop and administer individual, workgroup, and team performance assessments in a distributed, Internet environment and to obtain interactive performance assessments in near-real-time. In addition, research on team performance has underscored the difficulty and importance of gathering detailed objective information about the performance of individuals within a workgroup or team context for use in diagnosing errors in performance, identifying additional training requirements, and ultimately evaluating the successful or unsuccessful performance of the group or team. Finally, recent efforts to develop high fidelity performance assessment methods for aircrew members have demonstrated the importance of situationally-based criterion measures for performance and readiness assessments. An inexpensive, valid and reliable capability to systematically assess performance in near-real-time is required. Develop distributed, collaborative methods and criteria to systematically assess the performance and readiness of individuals, and individuals as participants in work groups and teams. Research to develop distributed performance assessment methods and criteria for use in evaluating the impact of a variety of selection, training, and design interventions on individual, workgroup and team performance and effectiveness will be conducted. The resulting technology and criterion measures may employ text-, digital video-, animation-, and/or simulation-based situations for performance assessment. For example, members of an aircrew could participate in a performance assessment of their Aerospace Physiology knowledge and performance by responding to a series of situations presented to them in text, animation, simulation, or video format via the Internet. Aircrew members will respond to a specific situation in different ways depending on their position in the aircraft. In previous, non-collaborative assessments, each member's response could not be evaluated within the context of the aggregate performance of the aircrew. Further, in most cases the actual criteria used to evaluate the performance was based on subjective ratings of observers and on reviews of after-action reports. Using the developed technology, all members of the aircrew can respond as individuals and can observe the responses of all other members. Some members may actually respond differently based on the given responses of other members. Also, the criterion performance measures are situationally-based assessments from which actual test scores would be obtained. This same performance assessment approach can also be used by dispersed members of a workgroup who must share information about a situation and arrive at a group response or decision. A distributed, collaborative approach for performance assessment not only provides critical information about how all members would perform in the given situation, but the data on their responses can be used to identify innovative solutions, misconceptions about the appropriate solution, and incorrect information that could be addressed in future collaboration or in follow-on education and training programs. Similarly, work groups and teams can be identified, assembled, and assessed more readily if relevant, objective performance measures are developed and used.

PHASE I: Phase I activities will result in a proof-of-concept technology for conducting performance assessments in a distributed, collaborative environment. Also, exemplary criterion measures and data collection methods will be developed for four domains. Two of the domains will be related to military workgroup and team performance and two will be related to non-military domains such as regional sales teams or product development teams. Phase I will also result in a final report.

PHASE II: Develop, apply, test, refine, and validate the distributed, collaborative, performance assessment technology and criterion measures and will develop additional criterion measures to assess workgroup and team performance and readiness. Proposals should assume that the technology will run in a Windows95TM, Pentium-based environment, but platform independent development is strongly encouraged. Phase II will also produce a final technical report.

PHASE III DUAL USE APPLICATIONS: The results from this effort are of considerable interest to the private sector as a means of gathering team productivity and performance assessments from dispersed work groups for use in identifying areas of high performance, areas of potential problems, and additional education, training, or management requirements. No assessment capability such as the one described herein exists. The benefits from such a capability to Government and private sector agencies could help organizations save considerable time and expenditures by targeting measurement to address specific areas of performance and productivity.

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AF98-013 TITLE: Java Tools for Developing and Delivering Distributed Training Over the Internet

CATEGORY: EXPLORATORY DEVELOPMENT; Manpower, Personnel, and Training

OBJECTIVE: Create a library of Java tools and techniques to enable adaptive, distributed training over the Internet.

DESCRIPTION: Solutions must be found to reduce the cost of delivering training. A primary cost for such training is that of travel expenses to transport, house and feed students. One potential solution is to deliver adaptive instruction over the Internet. To do this, a Java library of tools and techniques to enable adaptive, distributed training over the Internet is necessary. These tools would include routines for a) presenting information, including text, video, sound, and animations; b) collecting information about student performance; c) managing students records; and d) constructing, deploying, and grading tests or other diagnostic interactions. To reduce the costs of training large numbers of students from widely disparate locations, tools are necessary for building and delivering adaptive training over the Internet. These tools must include the following capabilities: a) presenting information, including text, video, sound, and animations according to an effective instructional design; b) collecting information about student performance; c) managing students records; and d) constructing, deploying, and grading tests or other diagnostic interactions. Special attention should be given to the advanced technologies available for advancing the state-of-the-art of graphics and simulations for Internet delivery.

PHASE I: The desired end products are 1) a proof of concept set of tools that demonstrate the products necessary to accomplish the goal of developing and delivering adaptive, distributed instruction over the Internet, 2) specifications for this set of tools that will be used to implement final products during Phase II. Phase I will also produce a final report.

PHASE II: The desired end product is a fully capable, completely finished software product to accomplish the objective, and a final report.

PHASE III DUAL USE APPLICATIONS: Tools built in this effort would be useful to all agencies in the DoD, and federal, state, and local governments. Additionally, they could be marketed to all commercial organizations involved in the development and delivery of training and education. These include consulting firms, corporations and companies with in-house training offices, and software development companies which produce training and education related products. The products of this project could also be marketed to secondary and post-secondary school systems.

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AF98-014 TITLE: Instructor's Associate for Rating Teamwork Skills

CATEGORY: EXPLORATORY DEVELOPMENT; Manpower, Personnel, and Training

OBJECTIVE: Develop a handheld input-output device that supports objective, standardized real-time instructor rating of aircrew teamwork skills and behaviors.

DESCRIPTION: There is a requirement for a tool that supports standardization of instructor ratings of aircrew teamwork skills and behaviors during simulations or performance on the flightdeck. The importance of training and evaluating teamwork skills has been identified as critical to enhancing performance and reducing accidents in both military and civilian aircrews. As a result, there is a growing acceptance of the need to base aircrew performance evaluations on aspects of crew coordination behaviors such as effective communications, as well as on aspects of technical proficiency, such as maintaining glideslope for landing. In contrast to technical aspects of performance which can be objectively measured and recorded by on-board instrumentation, crew coordination behaviors can only be rated by instructors in the aircraft or simulator. Current methods for capturing instructor ratings of aircrew coordination performance require either that the instructor divert attention from the act of observing on-going behaviors in order to make the ratings on a paper-and-pencil form or that the instructor make the ratings after completion of a flight or simulation based on recollection of what previously took place. Either method degrades the accuracy, objectivity, and standardization of the performance rating process.

An alternative approach to current methods of rating crew coordination behaviors and skills is to take advantage of computer technology to develop a handheld input-output device that is completely portable and convenient to use both in a simulator and on actual flightdecks. It is envisioned that the tool will record both structured, i.e., keystrokes on a numeric keypad, and unstructured, i.e., speech, instructor observations through an interface that facilitates the task of making performance ratings while minimizing demands on the instructor's attention. It is also envisioned that the tool will function both as a passive recording device and also as an intelligent associate that uses artificial intelligence technology to support the performance rating task. For example, the associate might recognize certain patterns of low performance ratings and prompt the instructor to add verbal notations expanding on the reason for the pattern of ratings.

PHASE I: Phase I will result in the a prototype hardware interface and software for the Instructor's Associate that passively records instructor inputs such as keystrokes and verbal comments. Phase I will also result in a technical report.

PHASE II: Phase II will result in full-scale development of the hardware interface and software for the advanced version of the Instructor's Associate that incorporates both passive and intelligent modes of data collection . Phase II will also result in a technical report.

PHASE III DUAL USE APPLICATIONS: A device to facilitate instructor rating of teamwork skills has applications to a number of organizations that require training of teams to perform effectively and efficiently, particularly in high-technology situations, such as aircrews, medical teams, and nuclear power plant operators. The portability of the Instructor's Associate makes it particularly applicable to organizations that conduct on-the-job evaluation of teamwork skills.

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AF98-015 TITLE: Advanced Voice Recognition Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop voice recognition technologies for use in high-noise environments to support aircraft maintenance repair activities.

DESCRIPTION: Head-mounted displays (HMDs) are being evaluated for the presentation of maintenance technical information to aircraft technicians performing repair and diagnostic activities. Head-mounted displays used with voice input can support hands-free maintenance with technical information that is available at all times. Voice recognition is the preferred method for documenting maintenance activities performed, and for quickly accessing technical information required for a specific maintenance task. Unfortunately, existing voice recognition technology does not work well when used in extremely noisy, dynamic environments, like the flight line. Technology needs to be developed to provide more effective voice recognition as a controller of HMDs for flight-line maintenance activities.

PHASE I: Define the hardware and software requirements and identify potential technologies to meet voice recognition requirements to support aircraft maintenance repair activities and result in a final report.

PHASE II: Produce an advanced voice recognition software technology product and demonstration plus a final technical report.

PHASE III DUAL USE APPLICATIONS: The voice recognition technology has numerous applications in the commercial and private sector. It is applicable in a wide variety of high noise settings where hands free computer input/control is required, including commercial aircraft maintenance, power plant operation, and manufacturing plant production control.

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AF98-016 TITLE: Low-Cost Eye Tracker for Head-Mounted Wearable Computer Displays

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Develop a miniature, low-cost eye tracking system that can be incorporated in or attached to head-mounted displays (HMDs) for wearable computer systems.

DESCRIPTION: The Air Force is currently developing and evaluating new approaches for hands-free control of wearable computers. Speech recognition provides one such option, but it is constrained by noise and by requirements for communication, privacy or stealth in some operations. Eye tracking would be highly applicable if a low-cost system was available that could be readily integrated with wearable computer HMDs. In such applications, eye line-of-sight would be used for the selection of icons and other computer functions. Therefore, eye fixations, rather than velocity or acceleration measurements would be of prime concern. In addition, only monocular eye tracking would be required. Typical fields of view for the monocular HMDs are in the range of 20-30 degrees of visual angle, horizontally and vertically. The following performance criteria should be addressed in the eye tracker design: (1) it must perform in operational environments under a variety of indoor/outdoor, user position/movement, illumination, temperature and humidity conditions, (2) it must operate with users who wear glasses and contact lenses, (3) it is expected that horizontal and vertical

eye position measurement accuracies of 1-2 degrees of visual angle will be required, (4) to maximize acceptance, the latency from user eye fixation to fixation determination (including software algorithms) should be no greater than 100 milliseconds, (5) it must add no more than 2 ounces of weight to the HMD and be readily incorporated in, or attached to, current HMD configurations, (6) calibration must take no more than a few seconds when the user initially dons the HMD and it must be self-administered, (7) because of possible HMD movement or slippage, an automatic adjustment routine is highly desirable, and (8) all components must be worn on the user's body and all software must operate on the wearable computer itself.

PHASE I: A fully functional conceptual prototype, integrated into at least one commercially-available wearable computer HMD, is highly desirable as the Phase I product.

PHASE II: The end product for Phase II shall be an advanced development prototype, packaged for field testing, that addresses all deficiencies identified in Phase I.

PHASE III DUAL USE APPLICATIONS: Given the anticipated demand for wearable computers to support maintenance, repair, delivery, law enforcement, military, medical, and other applications, there will be ample opportunities for commercialization of the Phase II product.

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AF98-017 TITLE: Advanced Audio Interfaces

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Enhance operational Air Force audio command, control, and communications systems.

DESCRIPTION: A requirement exists for effective audio command, control, and communications systems that are based on natural, intuitive interfaces using innovative abilities and requiring no learning or training for efficient operation. The intuitive interfaces facilitate operator task performance, lessen mental & physical workload, reduce fatigue, and improve personnel safety. These intuitive interface technologies include, but are not limited to: 1) auditory system modeling and neural networks for robust signal processing of speech, 2) digital audio technology to allow integration into aircraft systems, 3) noise-induced hearing loss protection, 4) active noise reduction, 5) three-dimensional auditory display for spatial awareness and communications. Innovation (e.g. auditory system modeling and neural networks) is needed in order for these technologies to be effective in high noise and high stress environments characteristic of military operations. This topic represents an opportunity for innovative ideas to be applied to individual components, the integration of multiple components, and the application of these to address current Air Force and DOD deficiencies in audio command, control, and communications and man machine interfaces. These issues will be even more important in the future within the reduced force structure environment.

PHASE I: Create an innovative interface concept, analyze operator performance and technology feasibility, and produce and deliver a proof-of-concept demonstration, including performance analysis.

PHASE II: Optimize the innovative interface system design, produce, evaluate, and deliver a full-scale prototype of the new interface concept, including full software documentation.

PHASE III DUAL USE APPLICATIONS: Commercial applications of these technologies are possible in the commercial aviation, entertainment, industrial safety, and health care fields, as well as in telemedicine and nuclear facility operation or in any high stress high workload environment.

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AF98-018 TITLE: Automatic Focusing Night Vision Goggle

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Develop an optical system for night vision goggles that will permit automatic focusing between close-up and infinity distances

DESCRIPTION: Night Vision Goggles (NVGs) are in wide use today. NVGs permit the wearer to perform tasks at night that the unaided eye will not allow. Ground forces, including medical personnel, and aircraft loadmasters often are required to manually focus the NVGs at a far away distance and then rapidly re-focus the NVGs manually for close-up viewing. This sequence of events is time consuming, fatiguing, and very inefficient. A requirement exists that will enable the NVGs to automatically focus for infinity distances and then re-focus automatically again for near sighted use (i.e., 18-24 inches). The weight will not increase significantly (less than 60 grams is desirable), and the technology must be capable of being integrated into currently-fielded systems.

PHASE I: A conceptual NVG brassboard that is fully functional and will demonstrate automatic focusing is highly desirable as the Phase I product.

PHASE II: The end product for Phase II shall be an advanced development working model, packaged for field testing, that addresses all concerns and deficiencies discovered in Phase I.

PHASE III DUAL USE APPLICATIONS: Law enforcement and border patrol activities involving surveillance or special tactics would be ideal for applications of this technology. This technology would also be beneficial to Army helicopter pilots.

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AF98-019 TITLE: Coordinated Team Performance in Complex Operational Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Develop design tools and methodology to enable the development of robust, distributive, multi-team performance in operational situations.

DESCRIPTION: Collaboration among individuals and subteams of individuals is a significant factor in many military operations (e.g., multi-place aircraft operations, battle management centers, UAV operations, air operation centers). Collaboration is needed to ensure coordinated operations and to increase mission precision. The coordination of individuals, teams, and systems of teams depends on advanced computer and computer network technology, communication media, and a broad range of support for individual and group information processing and problem solving. These technologies interact with (1) human system interface designs for augmenting collocated and distributive collaboration, (2) human factors' analysis tools (e.g., cognitive engineering) used to distill multi-operator and team knowledge and design needs, and (3) knowledge capture tools that define the situation from the individual performer and group performance perspective. Importantly, in many cases it is not sufficient to simply adapt user models of individuals, use single user oriented analytic design and analysis tools, or rely on a single-focus analysis of the operational situation. What is required, is to address collaborative performance in complex military systems on its own terms, from the first stage of conceptualization through the development of uniquely appropriate models, tools, situations, and concept demonstrations. We need to understand individual performance within teams, multi-interacting team performance, and be able to design human system interfaces that facilitate effective team performance. A requirement exists for the development of collaborative systems technologies,

including supporting team-centered design and analysis technologies.

PHASE I: Develop a fully rationalized conceptual working model for a design/analysis tool or suit of tools specifically geared to address the human-human and human-machine interface design problem in the context of complex military systems.

PHASE II: Provide a fully functioning alpha version of a design/analysis tool or environment. In addition, the tool/environment shall be used on a design problem to establish human interface design requirements or propose a design concept. A final report and briefing are required to document (1) the tool/environment, (2) procedures for its use, and (3) a description of its use, including design rationale, with an example problem.

PHASE III DUAL USE APPLICATIONS: The collaborative systems design/analysis tool would be ideal for use in telecommunication product design, computer software product design, and industrial engineering design.

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AF98-020 TITLE: Sensor Fusion and Information Warfare

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Develop a system to assess, integrate, and evaluate the robustness and vulnerabilities of sensor fusion technologies in an information warfare environment.

DESCRIPTION: With the major advances in sensor-related and computing-related infrastructure technologies over the last several years, and with new visions of theater architectures depicting highly-distributed but highly-connected systems, extensive opportunities are evolving for the application of sensor fusion techniques. However, as much as these architectures and capabilities offer opportunities for significant improvements in the overall quality of information available to warfighters, they also create opportunities for information attack on such systems. In spite of the application of advanced concepts of information protection and security, it is generally agreed that perfect protection of these systems is either technically impossible or unaffordable, or both. Since sensor fusion processes will likely be important elements of these vulnerable systems and architectures, it is important to understand the specific vulnerabilities and dependencies of sensor fusion processes on informational components, and to conceptualize and specify how to both protect the integrity of the information within these processes and how to overcome the effects of information corruption on sensor fusion operations. Additionally, it is of interest to assess how new and creative concepts of employment of sensor fusion processes can contribute to the realization of effective counter-information and counter-deception techniques, and the general notion of employing the sensor fusion process as a weapon. Finally, since sensor fusion processes most typically function in a decision-aiding framework, it is of interest to understand and evaluate the impacts of information operations on the human role in sensor fusion systems.

PHASE I: Conduct a comprehensive performance evaluation of potential information warfare methods and of data/sensor fusion approaches. Emphasis will be on the role of the operator in systems in which the fusion processes are employed as decision-aiding capabilities and the information attack is directed against the decision-making process. Specific examples will be identified and described. The effects of dissonant information on decision making will also be explored. The methodology and findings of the Phase I effort will be documented in a technical report.

PHASE II: Development and conceptual demonstration of a suite of analysis and design support tools which apply specifically to the sensor/data fusion capabilities of management and control systems. The demonstration will focus on the specific fusion applications identified during Phase I. A final technical report will document all progress on the project and a completed working model of the analysis/design system will be delivered.

PHASE III DUAL USE APPLICATIONS: Many non-military information systems and functions may well be the targets for information warfare (e.g., financial, transportation, power distribution, etc.). These systems all rely in some significant way on sensor/data fusion technologies and methods. The subject effort would provide methods and guidelines for assessing the vulnerability

of these system to information warfare attacks and for enhancing their robustness against such attacks.

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AF98-021 TITLE: Information Visualization Worlds in Air Operation Centers

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Develop a virtual reality world of an Air Operations Center that will allow users to navigate inside a data sensor information space.

DESCRIPTION: Currently, operators of Air Operations Centers must sift through and fuse huge amounts of data from numerous sensors operating in multiple spectrums, providing varying degrees of validity, and updating with many time periodicities. While much of the data fusion is handled by automatic means, the key issue still remains - how to find specific information that is relevant to the issue. Using advanced computer graphics, modeling, and database techniques, an information visualization paradigm can provide operators within a virtual world environment the ability to visualize large data structures, navigate within a virtual, three-dimensional, sensor data-space, and interact with objects while following a context-oriented search path.

PHASE I: Develop a conceptual Virtual Reality Modeling Language (VRML) world of an Air Operations Center that employs information visualization techniques for modeling, integrating, navigating, and portraying various information from numerous data sensors.

PHASE II: Provide a fully functional, advanced development implementation of the Phase I information visualization concept, and should address all concerns and deficiencies discovered in Phase I.

PHASE III DUAL USE APPLICATIONS: Interstate transportation; Commodity, stock, and currency markets; Medical imaging, and any market with voluminous data.

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AF98-022 TITLE: Ceramic Oxygen Generator

CATEGORY: EXPLORATORY DEVELOPMENT; Chemical and Biological Defense

OBJECTIVE: Develop ceramic oxygen generation technology using state-of-the-art oxygen ion conducting materials to generate 99.9% oxygen employing electrical power.

DESCRIPTION: The Air Force is interested in innovative methods of producing 99.9% oxygen. One particular area of interest is ceramic membranes that are capable of conducting oxygen ions when supplied electrical power. Currently, many types of ceramics exist that act as ion conductors. This oxygen generating technology is extremely similar to current fuel cell technology. In oxygen generation, oxygen ions are conducted across the ceramic material from the ambient air side to the pure oxygen side of the membrane by heating the membrane. Many specific technical challenges are inherent to ceramic oxygen generators. Membrane seals, thermal expansion differences, module optimization, and electrode/membrane conduction are some of the areas that require extensive research and development. Membrane seals are a challenge due to the high temperatures present in ceramic conduction. Also, differences in thermal expansion rates between the ceramics and possible manifolds and seals provide a technological challenge to be explored. Optimization in ceramic module configuration will allow for larger surface areas to maximize exposure to ambient air, while maintaining the integrity of the module. Because of the fragile nature of the material, a vibration environment may pose problems

if not specifically designed and engineered into the module configuration. Electrode/membrane conduction and connection have also proven to be technological hurdles in this system. The Air Force believes technologies exist to conquer these hurdles, however, integration of possible solutions has not been attained. By employing the ceramic technology, system size, weight, reliability, and performance will be improved over current Pressure Swing Adsorption (PSA) systems. Ceramic oxygen generation technology will also provide a breathing air purification if that air is challenged with contaminants such as chemical or biological agents, carbon dioxide, or carbon monoxide. Another advantage of ceramic oxygen generation over PSA technology is the elimination of a compressor inlet air source to operate the system. If advances in this technology could be made, tremendous dual-use applications will be available, such as oxygen generators for hospitals, welding, space and military applications. Although hospitals may not be interested in system weight/size, portable welding platforms and space applications will benefit from drastic technology improvements.

PHASE I: Demonstration of ceramic oxygen generation technology providing 99.9% oxygen using only electrical power. The demonstrator should produce 2 liters per minute of 99.9% oxygen. Although system size, power, and weight requirements are not defined, miniaturization is always desirable.

PHASE II: The ceramic oxygen generation capabilities would be improved to provide the generated oxygen at 50 psig without the use of an electrical compressor (which increases reliability and mean time between failures). This unit should also be able to withstand the rigors of vibration, altitude, and multiple start-up/shut-down cycles. This unit should produce about 15 liters per minute of 99.9% oxygen, weigh no more 40 pounds, use no more than 2.5 kW in electrical power and be no bigger than 1.25 feet x 1.25 feet x 1.25 feet. A breadboard would be delivered to Brooks AFB for continued evaluation and testing. Even though an exploratory research effort, this project would develop the ceramic technology with careful attention to producability, reliability, maintainability, and minimization of future sizes, weights, electrical requirements, and start-up times.

PHASE III DUAL USE APPLICATIONS: Hospitals for oxygen production; home health care for therapeutic purposes; oxygen production on aeromedical aircraft; welding companies for oxygen production (portable welding units and cheaper welding gases); and foreign countries with manned space programs (lighter oxygen systems will decrease payload costs).

REFERENCES: A. Khandkar and A. Joshi, |Solid Electrolytes: Emerging Applications and Technologies|, The Electrochemical Society Interface. Summer 1993, pp. 26-33.

AF98-023 TITLE: Ambulatory Psychophysiological Operator State Monitor/Recorder for Adaptive Interface Control

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Develop a self-contained ambulatory operator functional state monitor/recorder, based upon physiological data, that will provide reliable estimates across the full range of operator states.

DESCRIPTION: Operators of modern complex systems are a functional unit of the overall system. Optimal levels of operator state must be maintained in order to maximize system performance. Operator states, such as mental overload, fatigue, and inattention, degrade overall system performance. Psychophysiological measures, such as brain waves, cardiac activity, eye blinks and movements, respiration, and skin conductance, provide information about an operator's state. Multiple brain wave channels may be required. Several approaches are available to use these physiological features to determine operator state on-line, including neural networks, discriminant analysis, and Bayes classifiers. Reliable procedures for determining operator functional state in the workplace need to be developed and tested. A small, wearable, self-contained device is needed that will monitor operator state using physiological signals, record these signals for later review, and determine operator state based upon these signals in the context of the current work environment. Besides collecting and recording the physiological signals, the device will correct artifacts so that uncontaminated data can be used to determine operator state. Nonfunctional or degraded channels must be identified and marked. In addition, data from those channels would not be used until they are again operational. In order to provide the most flexible device, the classifier section should be modular so that different classifiers can be used when appropriate. This is also true for the signal processing portion of the system. Different signal processing modules should be available. For example, Fast Fourier Transform (FFT), wavelets, and filtering algorithms will be needed, as will the capability to add new techniques as they are developed. The capability to add more channels of data collection and reduction in the future should be considered. This flexibility will add to the potential use by other agencies, industry, and academia. Individual operator characteristics will have to be considered when determining operator state. Initial training of the classifiers for each operator may be necessary because of these individual response differences. In order to have practical value, an operator state estimator must incorporate relevant system/environmental variables. In order to do this, the device must communicate with the operated system and be able to incorporate this information into its calculations. In an aviation context, segments of flight are associated with known changes in physiology. For example, take-off and

landing are associated with increased heart rates and brain wave changes. Inappropriate physiological responses in these contexts are signals that the operator may not have an accurate awareness of the situation and corrective action must be taken. Continuous or graded levels of operator functional state estimates would be more useful than binary, yes-no types of output.

PHASE I: The product will be a design of a system, final report and working model, if possible.

PHASE II: Produce a working model system, including hardware and software necessary to collect and record physiological data. This system should also implement the operator functional state classifier and interface with adaptive systems.

PHASE III DUAL USE APPLICATIONS: Numerous applications exist for an accurate and reliable operator functional state monitor. They include monitoring drivers of automobiles, trucks and trains. Commercial aviation crew and nuclear power plant operators are further examples. Academic, industrial and government research and test and evaluation organizations would also make use of this device.

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2. Wilson, G. F., & Fisher, F. (1991). The use of cardiac and eye blink measures to determine flight segment in F4 crews. Aviation, Space and Environmental Medicine, 62, 959-961.

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AF98-024 TITLE: Enhancing Aviator Performance Through Psychological Skills Training

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE:. Research the potential of enhancing aviator performance in the cockpit and develop an appropriate Psychological Skills Training program.

DESCRIPTION: The utilization of Psychological Skills Training programs have been found to significantly enhance performance of elite athletes during both practice and competitive situations. Psychological skills training programs have been fully incorporated into the United States', Japan's, Australia's, Germany's and many other Olympic Training Centers with great success. Military aviators are considered to be very similar to athletes in regard to their specialized physical abilities and cognitive skills. It has been shown that athletes can improve their overall performance by improving their mental approach to performance. Such areas include, but are not limited to, dealing with the stressors of competition, maintaining concentration and focus, utilizing imagery to improve the precision of their performance, setting realistic and action focused goals, etc. The requested research on developing a Psychological Skills Training Program will incorporate both an assessment and training approach to enhancing performance.

PHASE I: During the initial phase, the research focus will be to transition existing Psychological Skills Training programs in the field of competitive athletics to the field of aviation. Identification of the specific psychological skill areas significant to aviation will be necessary. Once these areas are identified, a computer-based assessment device will be developed to measure an aviator's present level of individual skill utilization. The second component of this research endeavor will be to develop interactive computer-based independent training modules for each of the identified psychological skill areas. The focus of these designs will be to enhance the aviator's understanding of the skill, how it can be utilized and provide examples and simulated opportunities to practice each skill. The final product will be the entire Psychological Skills Training Program for aviators to include both the assessment device and the training modules fully documented in a technical report.

PHASE II: Normative data will be collected on the Psychological Skills assessment device to establish norms by which aviators will be compared. The assessment device and training programs will be field tested to determine the overall effectiveness as compared to existing criterion measures that are collected during either simulation training, undergraduate pilot training or other opportunities such as competitive events (Red Flag, Rodeo, etc.).

PHASE III DUAL USE APPLICATIONS: The Psychological Skills Training Program can be applied to other military situations that involve key decision making, technical training, and high-threat situations. This approach to performance enhancement is also applicable to commercial civil aviation, general aviation training programs, and collegiate level pilot training programs.

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5. Ogilvie, B.C. (1968). Psychological consistencies within the personality of high-level competitors. Journal of the American Medical Association, 205, 156-162.

AF98-025 TITLE: Affective Interfaces for Complex Crisis Situation

CATEGORY: EXPLORATORY DEVELOPMENT; Human Systems Interface

OBJECTIVE: Prototype and develop an affective computing system that demonstrates adaptivity in person-environment transactions as a function of a) affections and b) beliefs.

DESCRIPTION: Many human interfaces designed for military-based complex systems may be predicated upon identifying the cognitive factors underlying performance. In certain areas, intelligent interfaces may even adapt based on some determination of cognitive states. In the case of more advanced associate systems, mental models of the user are typically only based on |derived knowledge| from the user. However, the role of affection and beliefs are often not considered in the design of an intelligent interface/associate system. Yet, agent-environment interactivity in real world situations is increasingly dependent upon social considerations, conflict resolution, intuitive hunches, intrinsic values, application of beliefs, and emotional states. Perhaps this is most salient when rationale, normal procedures emerge into crisis settings that create highly volatile, stressful situations that create conflicts/disputes and require immediate attention. Such settings may also present belief as more important than knowledge and/or rules for action. Therein, there is a requirement to develop intelligent interfaces that adapt as a function of sensing/inferring an a) affective state and b) beliefs about an emerging crisis situation.

PHASE I: A review and descriptive framework that considers the role of affective computing and belief systems in agent-environment interactivity will be completed. Using this information and framework, a concept demonstration will be provided to show how an intelligent system would undergo adaptation based on sensing/inferring affective states and intuitive beliefs. A final report will document issues, the framework, reviews, progress, and associated findings.

PHASE II: An advanced breadboard will be developed/evaluated for a given military-based scenario to demonstrate principles of affecting computing and belief systems in action. The breadboard's effectiveness will be shown in the context of a crisis-based situation that can generalize to other applications and sectors. A final report will document issues, needs and requirements, tradeoffs, problems, and findings.

PHASE III DUAL USE APPLICATIONS: Nuclear power plants and electrical distribution centers, commercial airline flight control towers and integrated radar systems, space mission control centers, medical trauma units, metropolitan emergency management and fire-rescue units, national infectious disease monitoring and response units, police intelligence and drug intervention units, regional weather forecasting and warning centers.

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AF98-026 TITLE: Instructional Designers Engineering Associate (IDEA)

CATEGORY: EXPLORATORY DEVELOPMENT; Manpower, Personnel, and Training

OBJECTIVE: Develop software-based intelligent job aids to provide instructional design support functions for courseware authors.

DESCRIPTION: The product will be consistent with the ISD (Instructional Systems Design) approach but will go beyond traditional ISD by providing specific expertise on cognitive science as it applies to instruction. It will operate from an extensible knowledge base containing cognitive principles of human learning. By observing the authoring process, querying the author, and applying cognitive principles, the product will be able to answer structured queries regarding pedagogy, initiate messages to the courseware author about instructional opportunities and/or pitfalls in any current context, or provide relevant examples of instructional interventions that have been effective in the past. In addition, it will be able to save, load, and edit curriculum plans that can be ported to any Win95TM courseware delivery or presentation software that supports DLL-based (dynamic link library) curriculum drivers. This capability will allow course plans to be ported across Win95TM platforms and software suites, and allow the product to directly observe the authoring process.

PHASE I: The desired end products are 1) a proof of concept product that demonstrates the product necessary to accomplish the objective and 2) product specifications for use during Phase II.

PHASE II: The desired end product is a fully capable/completely finished software product to accomplish the objective, fully documented in a technical report.

PHASE III DUAL USE APPLICATIONS: This product can be used by all commercial markets that require development of training and education software.

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AF98-027 TITLE: Development and Integration of MEMS Based Sensor Technologies with E-SMART

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Provide a suite of sensor technologies that can be implemented with E SMART for addressing Environmental, Safety, and Occupational Health (ESOH) sensing and monitoring needs.

DESCRIPTION: The Air Force has an increasing need to quickly and accurately analyze the environment for chemical constituents. The cost of monitoring contaminated sites and point sources using current sampling and analysis techniques is extremely labor intensive and costly. More than half of the contaminated sites in the DOD will require long-term monitoring. Using today's methods, the cost of monitoring could exceed the cost of remediation. A number of DOD operations produce significant amounts of emissions which are largely uncharacterized, including aircraft operations, jet engine testing and aircraft painting/depainting operations, which will suffer operational restrictions when the new standards are promulgated. The current measurement techniques also involve field sampling followed by laboratory analysis, which are time consuming, labor intensive and costly. The purpose of this effort is to develop and integrate an on-site or remote, real-time, in situ measurement techniques with E SMART to determine the chemical composition and concentrations. MEMS based instruments and techniques that allow on site, continuous measurements without sampling are especially desirable, however other sensing approaches that provide advantages similar to MEMS will be considered. E SMART promises to integrate advancements in sensor technology with proven communication, electronic control, and analysis technology to produce a reliable, versatile, intelligent, cost-effective, environmental monitoring and control system. E SMART establishes standardized open network protocols for sensors, sampling systems, and graphical user interfaces for data visualization and evaluation. Only direct measurement techniques and submittals which include the basic planned strategy for taking the concept from development through commercialization of the final product will be considered.

PHASE I: Perform laboratory experiments showing integration to E-SMART and provide representative data on sample rate, specificity, spatial resolution, sensitivity, etc. The analysis of the data should include comparison with actual data gathered by current practices. Conceptual design work will also be performed under Phase I. A proof of concept demonstration with an engineering model at an Air Force site is strongly desired. A comprehensive technical report and plans for experimental development and commercialization will be the result of the Phase I and be proposed in a Phase II effort.

PHASE II: Perform extensive bench-scale testing, followed by field testing at Air Force designated sites. The engineering model shall be delivered to the Air Force for an in-depth evaluation of its potential along with a comprehensive technical reports documenting all of the work completed. Benefits to be gained from the use of the instrument will be quantitatively established for different potential applications to prepare for commercial development of the system. A more well-defined approach for commercialization should be presented.

PHASE III DUAL USE APPLICATIONS: The product would reduce the size, cost, and complexity of ESOH monitoring without the need for discrete sampling. Potential markets include the aircraft industry, automobile industry and other commercial manufacturers who must monitor to comply with the new ESOH standards.

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MEMS - Example Web Sites - http://mems.isi.edu/
http://mems.mcnc.org/memshome.html
http://esto.sysplan.com/ESTO/MEMS/
Draft E-SMART Node Specification - Contact Topic Author
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2) "Environmental Systems Management, Analysis, and Reporting NeTwork (E-SMART) - A Defense/Industry Technology Partnership," Nielsen, Bruce J.; Leffler, Steve; and Osborne, Denise; Proceedings of the NASA Technology 2005 Conference and Exposition, October 1995.
3) E-SMART Detects Contaminants, Bruce J. Nielsen and J. Steven Leffler, The Military Engineer, August-September, 1995.
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AF98-028 TITLE: Optical Sensors and Algorithms for Optimization of Target-to-Background Contrast

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop innovative optical (ultraviolet/visible/infrared) sensors and signal-processing techniques for optimization of target-to-background contrast ratio in structured environments.

DESCRIPTION: The Phillips Laboratory Geophysics Directorate's Optical Effects Division is interested in new sensors, signal-processing techniques and real-time data fusion techniques that exploit innovative approaches which leverage recent progress in commercial technology to detect targets in structured environments. Examples include passive optical systems such as imaging spectrometers and advances in sub-pixel target detection, image segmentation and anomaly detection. Many commercial technologies, such as those in detector arrays, electronics, data storage and processing, are emerging that could be developed into innovative systems. In addition, new data-processing techniques may take advantage of new artificial intelligence, neural network, self-learning algorithms, and other methods. The instrumentation and algorithms will be utilized in ground-based, airborne and space applications.

PHASE I: An analysis shall be conducted which compares the candidate optical sensor design to current technology in terms of sensitivity, spectral and/or spatial resolution, temporal resolution, size, weight, power consumption, et cetera. New data-processing algorithms will be defined and assessed in terms of achievable target enhancement and/or clutter suppression, as well as target-image reconstruction accuracy and speed. The effort should also include an investigation of ways in which the new technology could be applied to other military and commercial applications.

PHASE II: Develop a working optical sensor prototype and demonstrate operation in a laboratory environment. Tests shall be conducted to determine how effectively the design addresses the requirements of the intended application. In Phase II an automated near real-time data-processing system will be developed and demonstrated using synthetic and real data.

PHASE III DUAL USE APPLICATIONS: The sensor and algorithms developed under this effort will potentially be useful in Phase III in military systems requiring autonomous automatic target recognition under stressing conditions of sensor clutter induced by scene structure. It will potentially also be useful for non-military applications involving pattern recognition under similar conditions of scene-induced noise.

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AF98-029 TITLE: Range-resolved Continuous-Wave Lidar for Operation in the Visible-UV Range

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop a new type of compact lidar to detect and measure concentrations of gases that impact the operation of launch vehicles and spacecraft.

DESCRIPTION: Lidar systems are routinely used to measure atmospheric temperature, density, aerosols, and chemical gases in many Air Force projects. These systems, mostly based on pulsed laser sources, have inherent shortcomings associated with a pulsed source. For these systems, the pulse duration typically in the order of nanoseconds, and the low repetition rate often less than 100 pulses per second dictate a low duty cycle. The latter generally entails low detection efficiency and high optical peak power causing an ocular hazard. Almost all pulsed lasers of useful energies require a large and heavy power supply unit which makes the system unsuitable for sensor platforms of moderate sizes such as space orbiting platforms, unmanned aerial vehicles (UAV) and aircraft. Furthermore, these systems which often require intensive operator's oversight are too unpredictable to perform autonomously. To overcome the above shortcomings, continuous-wave (CW) devices such as laser diodes, with power and performance improving at a fast pace, are envisioned to be used in a new class of compact lidar systems of high duty cycle and low power consumption. Instead of depending on the short duration of the laser pulse to determine accurately time of flight and therefore target range, new approaches are sought to obtain range and Doppler information with a CW source. Such approaches include, but are not restricted to, amplitude and frequency modulation. The approaches selected by the performer are, however, required to be compatible with lidar techniques used to measure trace gases such as differential absorption and laser-induced fluorescence. Spectral flexibility is desired to selectively probe the absorption line and monitor multiple gases. Provisions are sought to extract Doppler signal and measure the line-of-sight velocity of the detected gases. The gases of interest to the on-going program are rocket exhaust plume effluents such as nitrogen dioxide, hydrochloric acid and chlorine. The criteria to evaluate the progress is based on the system's ability to detect those gases at concentrations 10 times less than typically found in ground clouds, spatial resolution better than 30 ft and temporal resolution better than 10 seconds. The listed application and criteria represent relevant candidates and valid benchmarks for the demonstration of this capability.

PHASE I: The proof-of-principles demonstration of CW lidar operation can be performed with a prototype on Rayleigh and Mie scatterers, atmospheric gas and aerosols, with range resolution and at a distance of up to 2 km.

PHASE II: Develop an experimental lidar system with differential absorption or fluorescence capabilities to measure plume trace gases to a nominal distance of 5 km. The system would demonstrate the potential to satisfy the requirements of autonomous operation, compactness and low power consumption.

PHASE III DUAL USE APPLICATIONS: NASA and commercial launch agencies would like to monitor the gas environment near

a launch site with inexpensive and autonomous remote sensors to document the environmental impact. Chemical companies and EPA could use these sensors to monitor the targeted gaseous effluents in an industrial park. As an example of commercial technologies that could later be inserted into military systems, these sensors could be mounted on UAVs to monitor of the chemical/biological environment in an area known to be contaminated or in a stand-off scenario. Affordable space-based lidars could be deployed to monitor spacecraft environment such as particles and degassed/released effluents.

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AF98-030 TITLE: Conductive Polymer Detectors for Chemical and Biological Agents

CATEGORY: EXPLORATORY DEVELOPMENT; Chemical and Biological Defense

OBJECTIVE: Exploit recent advances in electrically-conductive polymeric materials to develop low-cost, ultra-sensitive field-deployable sensors for warfare agents.

DESCRIPTION: As the threat of chemical and biological weapons increases, innovative sensors are becoming critical for protection of military and civilian personnel in a variety of operational scenarios. Due to the high toxicity of warfare agents, such detectors must be both extremely sensitive and species-specific. For maximum effectiveness, the agent sensors are be deployed in a badge format so that they can be worn by each individual. Thus each device must be low-cost, have a small footprint (credit card size), and use very little power (using, for example, a watch battery). One technology that has shown promise for selective detection of ultra-low concentrations of toxic gases is that of electrically-conductive polymeric materials. Sensors fabricated from these materials have been utilized for species-specific detection of toxic hydrazines and other hazardous gases down parts-per-trillion concentrations. Conductive polymers are inexpensive, and can be readily fabricated into small footprint sensor elements using simple techniques derived from the photoresist industry. The aim of this SBIR is the exploitation of advances in conductive polymer technology for the development of robust, field-deployable sensors for chemical and biological agents.

PHASE I: Choose a chemical or biological agent of interest (or an effective simulant) and explore its detectivity using conductive polymer materials. Construct a laboratory breadboard agent badge detector and utilize to demonstrate proof-of-concept.

PHASE II: Develop and test a prototype version of the chemical/biological agent badge detector. Deliver sufficient quantity of these detectors to AF for surety and/or field testing.

PHASE III DUAL USE APPLICATIONS: Dual use applications should be quite significant, especially in the chemical and agricultural industries, for detection of, and for personal protection from, pesticides and other toxic materials. Military users include AFHSC, AFIA, and DIA. Civilian users include EPA, FAA, chemical manufacturers interested in plant environment control, and, depending on cost, home owners interested in monitoring air quality.

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AF98-031 TITLE: Weather Forecast Aid in Conventional Data-Sparse Areas

CATEGORY: EXPLORATORY DEVELOPMENT; Battlespace Environments

OBJECTIVE: Develop a computationally efficient system to provide short-term mesoscale weather forecasts relying on non-conventional observations.

DESCRIPTION: Enhance current weather analysis and forecast systems by assimilating non-conventional observations into a numerical weather prediction model. The goal is to be able to produce accurate high-resolution short-term (0-12 hr) forecasts for a mesoscale domain (order 102-103 km) in remote regions. Currently models being run in conventional data-sparse regions are initialized using coarse resolution global analyses or forecasts with little if any observational data in the area of interest. Approaches

are sought to use non-conventional data sources to provide fine resolution detail of variables that are or can be related to the meteorological variables of temperature, pressure, wind, water vapor, cloud liquid water, and cloud ice. Examples of possible non-conventional data sources include but are not limited to space and ground based, active and passive, infrared, microwave and visible sensors. The enhanced weather and forecast system should be computationally efficient to run fast on a workstation that can be deployed in the field. The ability to deploy to the location where the forecast is needed will give the field forecaster the flexibility to configure and run the system as the situation dictates. Having the system ingest data and run the model at the field site minimizes the data links necessary and allows the forecast to reach the end user faster. Several other organizations are working in the area of mesoscale analysis and forecasting with numerical models on workstations, however none of these groups are focusing on assimilating non-conventional data. The design of the enhanced system should take into account the continually increasing computer CPU speeds. The system should have the ability to add more physical detail and more sophisticated assimilation and analysis techniques as CPU speeds increase.

PHASE I: Identify the non-conventional data source or sources to be assimilated and the mesoscale analysis and forecast system to be enhanced. Provide proof of concept that the non-conventional data will be an improvement over global analyses.

PHASE II: Identify additional non-conventional data sources to be assimilated. Develop a prototype of the enhanced system. The contractor shall deliver the developed software of the prototype system and a software user's guide and develop a plan for technology transition and insertion into future systems and commercial ventures.

PHASE III DUAL USE APPLICATIONS: The primary military application of the proposed system would be to deploy it at a forward location in a conventional data-sparse tactical theater where its products can be used directly for mission planning purposes such as flight planning and as input to Tactical Decision Aids. The resultant system would have commercial applications for those interested in the weather in remote regions. Government agencies responsible for monitoring and forecasting radioactive and toxic plume dispersions can use it to respond to releases in remote regions. Commercial aviation interests would be interested in using the improved capability to better forecast flight level winds, turbulence, and icing over remote ocean regions. The ability to better analyze weather features in remote regions can help U.S. and other countries to better predict tropical cyclone development and movement. Other potential applications including forecasting for off shore oil rigs and supporting search and rescue operations in remote regions.

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AF98-032 TITLE: Meteor Shower Impact on Upper Atmosphere

CATEGORY: EXPLORATORY DEVELOPMENT; Battlespace Environments

OBJECTIVE: Develop user-friendly software for prediction and analysis of effect of meteor showers on upper atmosphere

DESCRIPTION: Meteor showers occur annually and are modulated periodically by complex interaction of the earth's orbit with that of the parent comets and the break-up velocity of the fragments (meteors). For example, the well-known Leonid meteor shower, which occurs annually in mid-November, results from the breakup of the comet Tempel-Tuttle. Superimposed on this annual shower is a 33-year period; every 33 years the shower activity increases greatly. This increased shower activity leads to increased ionization trails and to increased optical emission from meteor metals, because of the larger mass deposition in the atmosphere. The likely effect of this periodicity is that the visible background radiation (airglow and nightglow) will be enhanced a great deal, and the ionosphere will be disturbed in such a way as to cause communications problems for advanced systems. The aim of this SBIR is to develop a code that can be operated on a workstation or a PC to allow the prediction of ionization trails generated by the meteor showers and to predict the optical backgrounds generated by the showers. Another aim of the code is to develop a seasonal and latitudinal

dependence of the natural background signatures, so that they may be used to assess the effect of shower activity on communications systems.

PHASE I: Describe the orbital mechanics of the meteor streams, parent comets, and earth and develop a program that will permit the prediction of seasonal and latitudinal variation in intensity. Define the processes that are needed for the prediction of communications and backgrounds effects.

PHASE II: Develop a code that can become a module to such standard codes as the International Reference Ionosphere (IRI) and Strategic High Altitude Radiance Code (SHARC). The output of the code will be a graphical description meteor shower and earth orbit intersections, emission intensities for the meteor metals, electron density enhancement by the trails, and populations of infrared emitters that are most likely to be affected by meteor flux.

PHASE III DUAL USE APPLICATIONS: The graphical description of meteor shower and earth orbit intersections has a large potential market to amateur astronomers and educational institutions. Military users include the 50th Air Weather Squadron and ESC offices concerned with above the atmosphere communications. Civilian users include commercial communications companies that depend on atmospheric transmission, amateur astronomers, and probably weather forecasting centers.

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AF98-033 TITLE: Dual Use Development of Laser Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Development of novel laser devices and/or laser technology for application within military and commercial markets.

DESCRIPTION: The mission of the Lasers and Imaging Directorate of the Phillips Laboratory is to develop high power diode-pumped solid-state lasers, diode lasers, diode laser arrays, and iodine lasers for military applications such as infrared countermeasures, combat casualty care, theater missile defense, national missile defense, and remote sensing applications for surveillance. These missions require laser materials interaction and sensing of the associated optical signature after the material is irradiated. Identical or very similar materials interaction occurs for commercial uses of laser technologies such as industrial applications, including materials processing and materials inspection; environmental applications, including optical sensing and decontamination; medical applications, including surgery or diagnostics; and law enforcement applications, including night vision, illuminators, and surveillance. Recent advances in lasers and laser materials have led to the development of new types of laser systems with substantially improved performance, including better frequency agility and different wavelengths. These advancements include development of more powerful lasers at novel wavelengths. As these advancements continue, it is important to review potential dual-use applications of these technologies to determine if new and innovative military and commercial products can be developed using them.

PHASE I: An in-depth assessment of potential military and commercial applications of a selected laser technology will be required. As a result of this assessment, the initial necessary product concept refinements will be determined and a product concept will be designed. Differences in packaging requirements between the military and commercial product will be evaluated and noted in the concept design report.

PHASE II: Build or fabricate, test and validate a laboratory demonstration model or prototype based on the commercial application assessment and the design refinements. Where possible, this prototype should have the capability to accomodate both types of applications and switch between the military use and commercial use setting, if necessary.

PHASE III DUAL USE APPLICATIONS: The Phillips Laboratory has greatly benefitted from dual-use development of its military developed technologies. Past dual-use efforts have established a source of supply for new laser products for both the military and the commercial sectors. When an immediate source of supply for laser technologies is readily available, the cost to the government is substantially reduced. For these reasons, the Lasers and Imaging Directorate considers the area of applications of laser technology to be an ideal dual-use area for LI technology. Some potential dual-use areas are industrial applications, including materials processing and materials inspection; environmental applications, including optical sensing and decontamination; medical applications, including surgery or diagnostics; and law enforcement applications, including night vision, illuminators, and surveillance.

AF98-034 TITLE: Dual Use Development of Optical Sensing/Data Handling

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop a high speed integrated data acquisition and data handling system for sensing and/or compensated imaging to be used in a commercial/industrial application.

DESCRIPTION: The Lasers and Imaging Directorate of the Phillips Laboratory develops compensated imaging systems and multispectral sensing systems for military applications. Compensated imaging requires active illumination, optical wavefront sensing, and wavefront correction. Even passive sensing requires considerable processing to shape the information into a meaningful form. Often the processing bottleneck of imagery or other data occurs after the detected signals are acquired and are then sequentially communicated to a separate computational processing platform. Novel integrated sensing and processing technology is required to enable real time image correction. Such technology would be capable of detecting and processing data and then correcting or enhancing the image dynamically. Developments in the integrated detection and processing technologies are suitable for example for medical applications or industrial inspection techniques during fabrication or assembly procedures where abnormalities are automatically highlighted in the processed images, generating control or communication response based on the processed information found within the data.

Rather than simply producing an enhanced image, the sensor could alternatively generate a response signal based on the information content it has processed from the sensed data. This technology would be suitable for applications where it is too slow or in some other way undesirable to have a person in the system to inspect images. Instead, the internal circuitry of the sensor itself would interpret the significance of information found within the data and then generate a response based on that information. Such a signal might, for example, sense an optical wavefront and control an adaptive electronic, mechanical, or optical correction system such as an array of switches or an actuation system for an adaptive mirror. The implementation of neural networks, fuzzy logic, and other "retinal" processing techniques integrated to the detection system can help process arrays of optical signals in parallel. Recent advances in IC design, material processing and fabrication have led to the development of smart sensing/imaging systems with the potential to perform detection and processing. Further advancements in the integration of hardware with processing algorithms that are uniquely suited both to image processing and to implementation in VLSI design are also sought.

PHASE I: Identify a potential commercial market for high speed integrated sensing (or imaging) technology, and perform an in-depth assessment of the potential market of a selected sensing technology. As a result of this assessment, an initial product concept will be determined and a sensing/processing system will be designed. A laboratory demonstration of the concept that demonstrates an integrated system including sensing/imaging, data acquisition and data reduction algorithm would be useful in determining the requirements of the product demonstration system.

PHASE II: Build or fabricate, test and validate a demonstration model or prototype based on the commercial applications assessment and the design concept. This production demonstration should include all of the relevant integrated fabrication processes necessary to determine drawbacks within the production process.

PHASE III DUAL USE APPLICATIONS: Military applications for this technology are enhanced autonomous optical sensors for surveillance, reconnaissance and control from unmanned air and space vehicles. Commercially, this technology can be used in autonomous defect detection, automatic manufacturing process improvement, and in enhanced diagnosis information in high data content medical images such as MRI images and tomographs.

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AF98-035 TITLE: High-Power, 1.9 micron Wavelength Semiconductor Laser Linear Arrays

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop high power monolithic linear arrays that can be integrated into stacked arrays greater than 0.5 Watts, continuous-wave, from a 200 micron aperture.

DESCRIPTION: Currently, InGaAsP/InP single laser diode emitters have been developed with output powers The purpose of this topic is to encourage the semiconductor laser community to further develop 1.85 to 2 micron, high power diode laser linear arrays that can be packaged into stacked arrays, similarly to the high power GaAlAs and InGaAs linear arrays which are now commercially available. The current limitation to fabricating high power InGaAsP/InP linear arrays is obtaining sufficient isolation between individual array emitters in order to suppress amplified spontaneous emission in the lateral dimension. Innovative approaches to isolating the individual emitters while still having a large percentage of the emitting-edge radiate laser light (large fill factor) is desired. The 1.85 to 2 micron linear arrays should possess the following characteristics: 1) high peak (> 40 Watts peak in 0.5 millisecond pulses) and average (>10 Watts) power from a 1 cm linear array, 2) greater than 15% electrical efficiency, 3) Quasi-CW operation (> 0. 5 millisecond pulse widths at 25 % duty cycle operation), and 4) operation at a heatsink temperature of > 5 degrees Celsius with a long lifetime (109 pulse lifetime).

PHASE I: Develop optimized approaches such as proton bombardment to isolate individual emitters in an InGaAsP/InP linear array. Test and demonstration of the technique on 1 cm linear arrays will be performed at lower fill factors.

PHASE II: Develop prototype high power linear arrays and multi-stacked arrays with the characteristics discussed in the description.

PHASE III DUAL USE APPLICATIONS: Laser diodes operating near the 2 micron wavelength region have many potential applications for medical and industrial systems as well as for optically pumping mid-infrared semiconductor lasers used in military systems. The two primary military applications for high-power, 1.9 micron wavelength semiconductor laser linear arrays are laser battlefield illuminators/designators and pumps for mid-IR semiconductor and solid state lasers used in infrared jammer systems for aircraft self-protection. One commercial sector application for these high power laser arrays includes pumping non-linear crystals used in mid-IR optical parametric oscillators and fibers used for optical communication.

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AF98-036 TITLE: Novel Packaging for High Efficiency Diode-Pumped Lasers

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop novel packaging techniques which enable high efficiency, ultra-compact, portable, diode-pumped lasers for commercial and military applications.

DESCRIPTION: Current packaging efforts for diode-pumped lasers have yielded systems which generate a few Watts optical radiation per pound of system weight. Novel packaging techniques may deliver 10-50 Watts per pound, which would dramatically enhance the fieldability of many diode-pumped laser systems. This SBIR topic will be used to investigate new methods for packaging existing diode-pumped laser technology into highly efficient, ultra-compact form factors. Particular emphasis will be given to mid-infrared wavelength lasers, but other spectral bands will be considered. Lasers using nonlinear optical techniques for generating desired wavelengths will also be evaluated. Ongoing research and development in the Air Force, other Government organizations, and industry can directly benefit from improved efficiency/weight and power/weight ratios.

PHASE I: Develop engineering associated with high wallplug efficiency, low volume/weight laser packaging. Additional consideration should be given to laser reliability and maintainability. Experiments, supported by theoretical analysis, should be performed which demonstrate possible packaging improvements. Demonstrations which concentrate only on the laser

head, ignoring power supplies and cooling technology, are not acceptable; the system includes these components and should include them in any power/weight design constraints. A market assessment for potential commercial applications should be accomplished, and a single market target should be selected. During this phase, a preliminary design for the Phase II device should also be developed.

PHASE II: Provide expanded proof of concept by fabricating a greater than 10 Watts average power, less than two times diffraction limited, laser source which delivers greater than 10 Watts per pound (total system weight, including power supplies and cooling. Continued experimental and analytical investigations of how technology improvements can further enhance the efficiency/weight and power/weight ratios should be an integral part of the Phase II effort. The prototype should be developed with emphasis on specific military applications and on the commercial market target identified during Phase I.

PHASE III DUAL USE APPLICATIONS: New laser packaging techniques developed under this effort will have a direct impact on commercial solid-state laser applications such as compact, airborne lidar for wind shear and remote sensing; mobile environmental monitoring systems; and other applications which require either mobile laser systems or compact packaging requirements due to platform constraints. The aforementioned commercial applications also have military counterparts; in addition, applications such as ballistic winds and infrared countermeasures would also be positively impacted.

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AF98-037 TITLE: Wavefront Detection with a Wide Dynamic Range

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop a wavefront sensor that can measure gross and fine optical aberrations in the visible for both membrane and segmented mirrors.

DESCRIPTION: The USAF Phillips Laboratory has recently undertaken the task of creating a large optical quality membrane telescope for use at visible wavelengths. The membranes on these large telescopes will range in thickness from 10 micrometer to 150 micrometers. This technology is very well suited for deploying an optical system to space, since the membranes can be packaged on the ground and erected after deployment. Traditionally, solid optics with sub-wavelength surface accuracy are used to build diffraction limited telescopes systems. Membrane mirrors cannot be built this accurately. The surface quality of an inflated membrane may initially contain millimeters of inaccuracies. However, the membrane actuation system will allow the membrane figure to be tuned to a more desirable shape.

This gives rise to the first area of interest. The surface figure must be monitored while using the membrane actuation system to adjust the figure. The figure will potentially be adjusted to within tens of waves of a diffraction limited surface. The residual error will be compensated by a separate active/adaptive optics system.

A second area of interest is optically aligning a segmented primary mirror from the initial deployment inaccuracies to within micrometers of a preferred surface. Initial deployment of a segmented mirror will involve large displacement and rotation errors. Millimeters of translation and milliradians of rotation will certainly be the best possible starting point. Larger errors are expected. Again, the residual error will be compensated by a separate active/adaptive optics system.

This topic solicits innovative methods for sensing large systematic dynamic surface aberrations that range from millimeters/milliradians to micrometers/nanoradians and provide continuous output signals that are compatible with an autonomous servo control system. Showing how to measure translations misalignments/aberrations as high as one centimeter or more and a relative rotations as high as one degree or more is a goal for this topic. The metrology system must have the dynamic range to continuously track these errors from the initial deployment inaccuracies to final figure requirements and provide useful output signals while this acquisition and control phase is accomplished. It is not enough that the sensor merely measure the optical aberrations; consideration must be given to its usefulness as a control system sensor. The types of algorithms for the interpretation of the

wavefront aberrations from the wavefront sensor output and the conversion of this aberration information to actuator control signals is important. The speed at which these control signals are provided is also important. Small or large aberration detection and its associated control signals should be generated at a rate of 10 seconds or less per figure measurement. The issues of segmented optics verses membrane optics may be quite different. Addressing both problems with the same approach or two separate approaches is acceptable. The response is acceptable even if only one of the two configurations is addressed

PHASE I: Design a sensor with the necessary dynamic range and control signal output format that will lend itself to the autonomous type of detection and control described earlier.

PHASE II: Build, test and validate a laboratory demonstration model or prototype based on the commercial application assessment.

PHASE III DUAL USE APPLICATIONS: A wide dynamic range optical sensor with appropriate output control signals has commercial potential in the following areas: solar collector surface mapping and tuning, simplifying optical alignment, tuning of theatrical membrane mirrors and automating the mass production of certain optical elements. The military application of this technology will support autonomous image acquisition and control of large deployable optical imaging systems.

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AF98-038 TITLE: Coherent Oxygen/Iodine Laser for Environmental Remediation

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Demonstrate the feasibility of utilizing coherent oxygen/iodine lasers for environmental remediation, including nuclear reactor decontamination and nuclear warhead decommissioning.

DESCRIPTION: The USAF Phillips Laboratory Lasers & Imaging Directorate invented and developed the high power Coherent Oxygen Iodine Laser (COIL) for military applications. Only COIL laboratory demonstration devices are operational. The PL has demonstrated thick steel section cutting with the kilowatt class COIL device. COIL operates at a wavelength of 1.315 microns. This wavelength is readily transmissible through standard quartz optical fiber. The COIL is the only laser which has the unique combination of very high power, extremely good optical quality, and fiber optic transmissibility. There are many environmental remediation applications which are or can be accomplished by first cutting the contaminated facility into small pieces and then hauling those pieces to a waste storage facility. The problem arising from contaminated and spent nuclear reactors is rapidly becoming an international concern since many reactors are now 35 to 40 years old and are reaching the end of their serviceable life. Currently there is no suitable plan to accomplish reactor decommissioning. In the military sector, there are a number of nuclear warheads which require decommissioning by a similar non-invasive technique of cutting into small manageable size pieces for recycling or disposal. The PL believes that a robotically manipulated, fiber optic delivered, transportable COIL system could be the ideal for employment in reactor decommissioning and warhead dismantlement as well as in removal of contaminated industrial-class chemical and nuclear facilities. The PL is interested in a systems-level engineering approach which, in addition to addressing remediation techniques, must also include the development of novel packaging technologies necessary for a transportable, as well as reliable COIL device. Additionally, the required systems engineering would have to include the development of COIL device employment strategies. We anticipate that small businesses interested in pursuing this topic would need to have or must develop access to institutions with resources necessary to actually construct a COIL device based on designs developed by the small business. Experience in or access to expertise in large-scale portable environmental remediation systems will also be necessary.

PHASE I: An in-depth assessment of the environmental cleanup problem, including nuclear reactor decommissioning and nuclear warhead dismantlement utilizing COIL technology, will be required. As a result of this assessment, an initial system concept will be defined. The purpose of the concept definition is to identify requirements for validation experiments to definitively demonstrate the viability of the concept for environmental cleanup and nuclear weapon decommissioning.

PHASE II: Utilizing existing laser facilities, such as the one at PL, accomplish the necessary validation experiments to evaluate the viability of the COIL system concept. That is, validate high power fiber optic transmission and nuclear waste and warhead material cutting. Incorporate the experimental data into a refinement of the system concept. Complete the system design. The successful completion of Phase II should provide everything that is necessary to build a robotically manipulated, fiber

optic delivered, transportable COIL system to accomplish nuclear reactor decommissioning, nuclear warhead dismantlement and other chemical and nuclear environmental cleanup tasks.

PHASE III DUAL USE APPLICATIONS: There is a large number of spent nuclear reactors and other environmentally contaminated facilities that require a viable concept for decommissioning, so the commercial market is very large. There is also a substantial number of nuclear warheads which are outdated and beyond their useful lifetime. However, decommissioning is the responsibility of a Federal Agency, and nuclear warhead dismantlement is the responsibility of the Defense Department. The Phillips Laboratory is looking for small businesses with expertise and/or access to expertise in systems engineering as it applies to the development of large-scale high power lasers as well as expertise in environmental remediation. The innovative developments resulting from this SBIR topic also have strong applications in the military community. The military also has spent and/or contaminated reactors which must be decommissioned. The military also is responsible for other contaminated facilities where this technology could be employed in remediation. This technology will also be useful in the demilitarization of strategic facilities and/or weapons systems. The purpose of this project is to develop a dual-use source of expertise for COIL lasers which is applied to the commercial and military environmental clean-up, including nuclear reactor decommissioning and nuclear warhead dismantlement.

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AF98-039 TITLE: High Power Eye-Safe Laser Diodes with Low Alpha Structure

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop high-power diffraction-limited laser diodes at eye-safe wavelengths by designing and using structures that have a reduced linewidth enhancement factor (Alpha).

DESCRIPTION: Higher power diode lasers are sought for a number of Air Force applications at and beyond 1.55 um, additionally there are numerous commercial applications for high power lasers. When scaling diode lasers to higher power by simply enlarging the stripe width, a self-focusing effect causes the lasing mode to break-up into a number of mutually incoherent filaments thereby ruining the beam quality. A laser built with a low-alpha design would presumably not suffer from this beam quality degradation, and thus wider lasers with higher power would be achievable.

PHASE I: Design and model laser structures which exhibit small values of alpha.

PHASE II: The Phase II effort will require the fabrication, test and refinement of the designs developed in Phase I.

PHASE III DUAL USE APPLICATIONS: Many of the Air Force applications for this technology have important commercial parallels, such as satellite crosslinks, uplinks and downlinks. The objective of Phase III is to make high power 1.55 um semiconductor lasers commercially available for both private-sector and military applications. Other dual use applications include: laser radar, laser rangefinding, and laser illumination.

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AF98-040 TITLE: Eye-Safe, Infrared Laser Communicator

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop an eye-safe, light weight, low cost, battery powered laser system for short range line-of-sight voice communications.

DESCRIPTION: Radio frequency communications are not directional, making them subject to interception, jamming and relatively easy location of the transmitter. Laser based communications wouldn't have these shortcomings, but in order to achieve moderate range (>1 mile) or to utilize wide angle transmission, requisite power levels make eye safety an important issue. By using semiconductor lasers operating at 1.55 μm or longer wavelengths the laser power can be increased safely. This communicator will be small, light weight (belt or helmet mountable) and battery powered. It will be capable of sending and receiving voice transmissions.

PHASE I: Design a simple laser communicator and fabricating several prototypes.

PHASE II: Optimize the design from Phase I, tailor this design to particular applications, and field test the system. A few prototypes would be built for some of the envisioned applications.

PHASE III DUAL USE APPLICATIONS: Military applications envisioned include: ground team communications, where individuals on a team would be able to communicate with each other with a wide angle beam, or at some distance with a more tightly focused beam; a local area intercom, where personnel in the vicinity of a ground vehicle or an airplane would be able to communicate with the crew onboard, via vehicle mounted laser receivers/transmitters; and cockpit to cockpit for secure in flight communications. Several commercial applications are possible where short range, secure and cheap line of site communications are desired. Potential use of such a communicator would be for private vehicle-to-vehicle conversation, communications at construction sites, installation into motorcycle/bicycle helmets, and others.

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AF98-041 TITLE: Spectral Imaging

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop optical remote imaging systems for counter terrorism and counter proliferation.

DESCRIPTION: Several existing or emerging optical imaging and sensing technologies have application for both military operations and counter terrorism. It is possible to see into automobiles through darkly tinted glass using infrared imagers with specially tuned optical filters. Narrow band IR illuminators might also be required.

We are also interested in sensor technologies that can be used to detect chemical emissions that indicate drug processing activity, inside a building or hidden behind trees. Similarly, vehicles and electrical generators with internal combustion engines could be found behind foliage. Camouflaged aircraft or vehicles could be found using hyperspectral or polarization sensing techniques.

Hand held telescopes with image stabilization and adaptive optics are now becoming feasible. This is driven by recent advances in micro electromechanical machines (MEM), deformable mirrors and liquid crystal optical Phase correctors Such a system might extend the useful magnification of hand held binoculars by a factor of ten.

We seek proposals to develop optical sensing systems for counter terrorism, counter proliferation and law enforcement. Inexpensive hand held sensors are preferred, but small automobile, aircraft or ship mounted systems may be acceptable. Systems must be very user friendly so that these systems could be used by personnel with little or no specific training.

PHASE I: Produce a proof of concept. Investigate various approaches during Phase I, and demonstrate through modeling, analysis, and/or experiment the feasibility of their proposed remote sensing concept. The results of the Phase I effort should clearly demonstrate not only the feasibility, but establish a defined approach for a Phase II effort. Commercialization and dual-use applications should be developed and potential partners identified.

PHASE II: Develop and demonstrate a prototype system capable of operating under realistic conditions.

Demonstrate a capability with a clear commercial potential. Develop commercial partnership interests for a Phase III production and marketing program.

PHASE III DUAL USE APPLICATIONS: Military counter terrorism equipment can be used for non-military counter terrorism and law enforcement with little or no modification. Local police departments, private security companies, security departments in large corporations, and federal law enforcement agencies (FBI, DEA and ATF) are some potential customers.

REFERENCES:

1. Kolb, C.E., Instrumentation for Chemical Species Measurements in the Troposphere and the Stratosphere, Reviews of Geophysics, Suppl., Apr 91, pp. 25-36
2. The Infrared & Electro-Optical Systems Handbook, vols. 4-6, 8, ERIM Infrared Information Center, Accetta and Shumakr, eds. 1993.
3. Substance Identification Technologies, Proceedings of SPIE EuroOPRO Series V. 2093, Flanagan, Ed., 1994.

AF98-042 TITLE: Remote Sensing

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop optical or radio frequency remote sensing systems for counter terrorism and counter proliferation applications.

DESCRIPTION: Lidar could detect chemical emissions that indicate drug processing activity inside a building, even if concealed behind trees. Similarly, vehicles with internal combustion engines could be found behind foliage. Remote wind measurements could be used to predict the path of a cloud of toxic chemicals.

The key to making lidar practical is the laser source. A solid state, efficient, robust, compact, tunable laser in the IR or UV part of the optical spectrum is required. A tunable UV laser could be used for Raman, Differential Absorption Lidar (DIAL), Laser Induced Fluorescence (LIF), or for Doppler wind measurements. Such systems could detect water vapor, chemical agents or biological agents. They could also be used for wind field measurements. Frequency agile lasers in the 10|14 micron range could also be used for DIAL chemical detection systems.

Currently, military night vision equipment works very well, but its high cost prevents more widespread use outside the military. We are interested in innovations which reduce the cost of such equipment.

Radio frequency systems could remotely detect obscured objects such as mines, unexploded ordnance, buried structures, buried firearms and vehicles hidden beneath foliage.

We seek proposals to develop remote sensing instruments for counter terrorism and counter proliferation. Inexpensive hand held sensors are preferred, but longer range systems for use on automobiles, aircraft or ships are acceptable. Systems must be very user friendly so that they may be used by personnel with little or no specific training. We also seek proposals for small, rugged, efficient illuminators to be used in the systems described above.

PHASE I: Produce a proof of concept. Investigate various approaches during Phase I, and demonstrate through modeling, analysis, an/or experiment the feasibility of their proposed remote sensing concept. The results of the Phase I effort should clearly demonstrate not only the feasibility, but establish a defined approach for a Phase II effort. Commercialization and dual-use applications should be developed and potential partners identified.

PHASE II: Develop and demonstrate a prototype system capable of operating under realistic conditions. Demonstrate a capability with a clear commercial potential, and develop commercial partnership interests for a Phase III production and marketing program.

PHASE III DUAL USE APPLICATIONS: Military counter terrorism equipment can be used for non-military counter terrorism with little or no modifications. Local police departments, private security companies, security departments in large corporations, and federal law enforcement agencies (FBI, DEA and ATF) are some potential customers.

REFERENCES:

1. Rothwell, E. J., et. al., Time-domain Imaging of Airborne Targets using Ultra-Wideband or Short-Pulse Radar, IEEE Transactions on Antennas and Propagation, Vol. 43, No. 3, March 1995.
2. Sower, Gary D., Detection and Identification of Mines from Natural Magnetic and Electromagnetic Resonances, Proceedings of the International Society for Optical Engineering, Orlando FL, April 1995.
3. Felsen, L. B., ed., Ultra-Wideband, Short-Pulse Electromagnetics 2, New York, Plenum Press, 1995.
4. Baum, C. E., Target Signatures and Pattern Recognition, Interaction Note 501, Phillips Laboratory, February 1994.

AF98-043 TITLE: Small Inertial Attitude Reference System

CATEGORY: EXPLORATORY DEVELOPMENT; Chemical and Biological Defense

OBJECTIVE: Develop a small inertial attitude reference system that will contain a stable mirror to reference optical systems.

DESCRIPTION: This project will design and produce a small and inexpensive inertial attitude system that can be used with a telescope, or in an airplane, or in a land vehicle as a two axis optical inertial reference. This type of an instrument could be very useful to a program such as the Airborne Laser that requires an inertial reference for optical pointing. The system is desired to be small enough that it could be mounted on the secondary mirror of a beam expanding telescope, the goal is to keep the instrument package within a cube 3 inches on a side. The intent of this effort is to conceptualize, design, and produce a prototype unit that is an inexpensive and small inertial attitude reference. An optical surface, such as a small mirror will be included in the system to provide an inertially stable optical reference. It would be possible to add accelerometers to this unit and obtain a navigation system. However, only the attitude reference will be designed and built under this contract, navigation software will be added by the contractor as he deems necessary.

PHASE I: Design the attitude reference system and demonstrate to the Air Force that such a miniature system is within the state of the art. This phase will prove the feasibility of producing the small package and show how this package can be used with a telescope to significantly improve the pointing accuracy. The system will be able to operate and measure angular inputs while the telescope is slewing at 1rad/sec and 2 rad/sec/sec acceleration. It must be able to survive higher rates and accelerations but may saturate. The angular error in the optical reference of this system shall be less than 3 microradians when subjected to the vibration spectrum of a C-135 at 40,000 ft altitude and 0.8 mach number, and less than 1.5 microradians under quiet laboratory operation. Design reviews will cover the components, the system design, and control design concepts for the entire system.

PHASE II: Procure, assemble, and demonstrate the components for the 2 axis attitude reference system. The instrument shall be demonstrated as a complete system. It is expected that this phase will demonstrate the system operation and include detailed characterization of the control loop performance. If desired the Air Force will work with the contractor to obtain use of the inertial test equipment at Holloman AFB.

PHASE III DUAL USE APPLICATIONS: It is expected that a competitively costed ultra small system as conceptualized here would have several commercial and military customers. The military applications will be on all sorts of pointing telescopes for imaging and for optical communication systems. The commercial use of the system would include navigation systems for land vehicles and possibly aircraft. If the price can be made low enough for the automobile industry, the product would obviously have a huge market. It is expected that the contractor will design a system with many options during Phase 1, so that as large as possible commercial market will be available.

REFERENCES: Gyroscope Theory, Design, and Instrumentation, Wrigley, Hollister, and Denhard, The MIT Press, Cambridge, MA, 1969.

AF98-044 TITLE: Contamination Control for Space-Based Optical Systems During Ground Operations and Storage

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop innovative approaches for preventing optical sensor degradation due to contamination during storage.

DESCRIPTION: Spacecraft flying optical payloads are exceptionally sensitive to contamination. This is especially true for space-based sensors designed to locate dim targets in a bright background. To minimize such contamination, control measures must be incorporated during system fabrication and carried through testing, integration, and storage until the sensor system is deployed. Past measures used to prevent contamination during storage, testing and integration prior to launch have not always been effective; sometimes leading to the need for disassembling and cleaning sensor components just prior to launch. Such delays are costly, and would effectively cripple access to space in a future scenario requiring stored sensor assets to be launched on demand.

PHASE I: Determine the initial cleanliness levels needed to meet end-of-life performance requirements on space-based optical sensors. Develop innovative concepts for preventing and monitoring particulate and molecular contamination accumulation during all phases of (post fabrication) system ground handling. Provide demonstration of prototype prevention/monitoring device operating at cleanliness levels better than class 300.

PHASE II: Fabricate/demonstrate a ground contamination control system, utilizing a sensor test-bed incorporating advanced design cleaning techniques, in-situ monitoring-removal-collection devices, and storage packaging methods.

PHASE III DUAL USE APPLICATIONS: A sensor ground contamination control system will have equal application in relation to DoD and commercial satellites. In addition, effective contamination prevention/removal/ collection and monitoring capabilities are needed in many industries. Semiconductor and optoelectronic manufacturers have a particularly urgent requirement for this technology as they strive for ever smaller devices, higher reliability and lower production costs.

REFERENCES:

1. SPIE Vol. 2864, ROptical System Contamination V and Stray Light and System Optimization (1996).
2. SPIE Vol. 777, ROptical System Contamination; Effects, Measurement, Control (1987).

AF98-045 TITLE: Advanced Rocket Propulsion Technologies

CATEGORY: BASIC RESEARCH; Aerospace Propulsion and Power

OBJECTIVE: Develop innovative components, manufacturing and processing techniques, and integration technologies aimed at doubling existing rocket propulsion capabilities by the year 2010.

DESCRIPTION: There is a critical need for novel, innovative approaches to develop technologies which can double existing rocket propulsion capabilities by the year 2010, and for bold, new, non-conventional aerospace propulsion-related technologies which will revolutionize aerospace propulsion in the next century. These revolutionary concepts, based on sound scientific and engineering principles, are essential in order to increase performance and mission capability while either maintaining existing or decreasing life-cycle costs. The proposed solutions shall emphasize dual use technologies that clearly offer civilian/commercial as well as military applications. Proposals emphasizing spin-on technology transfer from the civilian/commercial sector to military applications will receive additional consideration.

Our technological goals include: 1) Improve specific impulse and mass fraction for boost and orbit transfer, spacecraft, and tactical missile propulsion. 2) Reduce the stage failure rate and hardware and support costs for boost and orbit transfer propulsion. 3) Improve the thrust to weight ratio for liquid rocket engines. 4) Improve the total impulse to wet mass ratio for electrostatic and electromagnetic satellite propulsion systems. 5) Improve density impulse of monopropellants for satellite propulsion systems. 6) Improve the delivered energy of tactical missile propulsion systems. In the conduct of rocket propulsion research we strive to reduce environmental hazards from propellant ingredients and processing, propulsion exhaust, and rocket motors while either maintaining or surpassing current propulsion efficiency.

Improvements in the operability, reliability, maintainability, and affordability of space launch applications, for example, might include development of novel systems which can be launched with short lead times for a relatively low life-cycle costs. An example of such a concept may include the design and development of a rocket-based combined cycle (RBCC) engine. Such systems would need to demonstrate high reliability and maintainability levels.

Subsets of advanced rocket technologies would have lengthy shredouts of potential research subjects but are not stated here in detail. These technologies might include the need for innovative combustion and plume diagnostics (i.e. application of electro-optical devices and sensors), performance predictions, modeling of exhaust plume radiation and combustion characterization, propellant and component service life prediction technologies, and environmental contamination.

Additionally, bold, new advanced propulsion and related technological concepts and products for space activities are solicited for development. These topics include revolutionary concepts in very advanced fuels and oxidizers, metastable high energy nuclear states, storage of antimatter in chemical matrices, nanotechnology products and techniques applied to rocket propulsion, enigmatic energy devices, and field propulsion thrusters. Research in these advanced rocket propulsion topics are included and structured to provide a maximum of innovative flexibility while yielding promising commercial applications/dual-use technology applications to prospective investigators.

Proposals also submitted for any other USAF Phillips Laboratory FY98 Small Business Innovation Research (SBIR) topic shall not be considered for this topic.

PHASE I: Further develop the concept and perform analyses required to establish the feasibility of the proposed approach.

PHASE II: Complete the Phase I design and develop a demonstrator or prototype. Document the R&D and develop a technology transition and/or insertion plan for future systems and commercial ventures.

PHASE III DUAL USE APPLICATIONS: Advanced rocket propulsion technologies will transition to new, higher performing and/or lower cost U.S. Military and commercial rocket engines and motors or advanced propulsion systems. This will enable the U.S. aerospace industry to increase global market share for space launch opportunities by reducing the life-cycle cost and increasing the efficiency of inserting payloads in orbit. Advanced rocket propulsion technologies also serve the commercial sector by enhancing our ability to remanufacture components to maintain and monitor the health of the U.S. ballistic missile fleet.

REFERENCES: Selected Bibliographies, Handbooks, Manuals, and Reviews, CPIA SB-94, Nov 1994.

AF98-046 TITLE: Innovative Radiative Transfer Modeling for Rocket Exhaust|Base Flow/Signature Prediction

CATEGORY: EXPLORATORY DEVELOPMENT; Battlespace Environments

OBJECTIVE: Develop innovative radiative transfer model for predicting three dimensional effects of rocket exhaust plumes on vehicle base heating and plume signatures.

DESCRIPTION: Radiation modeling of rocket exhaust vehicle interactions and signatures is currently accomplished using technology approaches that were selected 20-30 years ago, when computer resources were orders of magnitude less than they are today. This led to the rejection of accurate and general approaches that should be reexamined in the light of the current and future availability of fast, inexpensive, workstations, as well as, shared and distributed memory parallel computer systems. At this time it should be possible to formulate a unified approach that: covers the complete infrared through ultraviolet spectrum of interest; is valid over the complete altitude range from sea level to space; includes two-phase and scattering effects; allows for correlated and uncorrelated approaches; and can accurately treat both equilibrium and nonequilibrium radiation without overly limiting included mechanisms or use of overly restrictive band model assumptions. The resulting methodology should be implemented in a manner that facilitates use by non-experts in the field; allowing them to address three dimensional design problems on a reasonable time scale. The radiative transfer computer code should also be capable of accepting temperature and species concentration outputs from a wide range of continuum and Monte Carlo flow codes.

PHASE I: Review deficiencies of current radiation transfer models. Formulate a modern, innovative approach for unified, three dimensional, two-phase radiation analysis. Conduct limited feasibility demonstration on two-dimensional single phase problem.

PHASE II: Complete development of the radiative transfer prediction model. Conduct validation studies sufficient to demonstrate accuracy and efficiency of the model across its full range of intended defense related and commercial sector applications. Incorporate features to enhance usability by non-specialists and provide clear and complete documentation. Prepare and deliver a well documented plan for technology insertion into Air Force and DoD systems and into commercial applications.

PHASE III DUAL USE APPLICATIONS: This radiative transfer prediction model should be applicable to a wide range of defense related concerns such as rocket and aircraft airframe/propulsion system integration for efficiency and stealth, sensor design for early missile warning, launch site detection, missile and reentry vehicle tracking, and kill assessment. Potential commercial sector applications include remote sensing of pollutant emissions, monitoring the performance of industrial burners, use of IR or UV-Vis absorption spectroscopy to control manufacturing processes in the chemical industry, commercial aircraft exhaust sensors for controlling performance and emissions, and satellite monitoring of natural and man made radiation sources.

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1. Freeman, G. N., Ludwig, C. B., Malkmus, w., Reed, R. Development and Validation of Standardized Infrared Radiation Model (SIRRM). Gas/Particle Radiative Transfer Model, AFRPL-TR-79-55, 30 Oct 79.
2. Bernstein, L.S., Berk, A., Robertson, D.,C. and Acharya, P.K., Addition of a Correlated -k Capability to Modtran, Proceedings of 1996 Iris Targets and Backgrounds Meeting, January, 1996.
3. Bernstein, Lawrence S. Treatment of the Layer Temperature Gradient Problem in Band Model Emission Codes, Applied Optics, Vol. 34, No. 3, 20 January 1995.

AF98-048 TITLE: New Approaches to Energetic Materials Decomposition Mechanism and Kinetics Studies

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop and demonstrate techniques for the identification of nascent and transient species during the rapid pyrolysis of energetic materials.

DESCRIPTION: The efficient development of new, solid energetic propellants and oxidizers requires detailed knowledge of their mechanisms and kinetics of decomposition. This information is needed to provide insights on how to definitively evaluate, tailor, and optimize the performance of emerging and unforeseen molecules of interest. Suitable techniques must, therefore, have a time-resolution of one microsecond, a broad range of detectable decomposition products (NH_3, NO_2, NO CO_2, organic fragments, etc.) a pressure range beyond one atmosphere, and a temperature ramping capability of ca. 500 K per microsecond. An additional vital

requirement is the ability to study low vapor pressure solids, neat ionic solids, and ionic solids dissolved in polar liquids. One promising approach consists of pulsed infrared laser sample pyrolysis coupled with synchronized, step-scan FTIR detection of nascent and evolving species. Acceptable responses to this solicitation would include a) innovative approaches to the required sample delivery for IR laser pyrolysis - step-scan FTIR analysis and for sensitizing solution samples which do not directly absorb the pyrolysis laser or b) novel alternative strategies for pyrolysis kinetics/mechanism investigations of solid energetic materials which satisfy the above criteria.

PHASE I: Strategies which address either a) innovative approaches to the required sample delivery for IR pyrolysis - step-scan FTIR analysis and for sensitizing solution samples which do not directly absorb the pyrolysis laser or b) novel alternative strategies for pyrolysis kinetics/mechanism investigations of solid energetic materials should be described in terms of their projected capabilities. Proof of concept demonstration is required in either case.

PHASE II: Develop and demonstrate prototype hardware of the technique explored in Phase 1. All hardware and software developed shall be delivered, and a well documented plan for commercial applications shall be prepared.

PHASE III DUAL USE APPLICATIONS: The turnkey instrumentation package developed in Phase III will provide DoD and private sector laboratories with hardware to investigate the rapid high temperature pyrolysis kinetics and mechanisms of a wide range of systems. This unique system will have a large commercial market since this versatile sample delivery, time-resolved instrumentation will streamline the design of new classes of molecules with optimized performance for a variety of applications which include a) gas generators for air bags with increased storage life and reliability, b) commercial explosives with reduced sensivitiy to unintentional discharge and uncompromised performance, c) semiconductor dopant precursors which offer higher wafer yields, d) energetic materials for rocket and air breathing propulsion with tailored performance, and e) improved refractory lining and nozzle materials for propulsion systems.

REFERENCES:

1. Botcher, T.R. and Wight, C.A., "Transient Thin Film laser Pyrolysis of RDX ", Journal of Physical Chemistry, 97, 9149 (1993).
2. Johnson, T.J. , Simon, A., Weil, J.M., and Harris, G.W. , " Applications of time-resolved step-scan and rapid scan FT-IR spectroscopy: Dynamics from ten seconds to ten nanoseconds", Applied Spectroscopy, 47, 1376 (1993).

AF98-049 TITLE: Optical Quality Measuring Device (OQMD)

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop a flight-weight measurement device to determine optical quality of 9m X 7m solar concentrator in space and on earth.

DESCRIPTION: A thin film inflatable concentrator system is to be ejected and then deployed in space at approximately 350 km altitude in Low Earth Orbit (LEO). The off-axis parabolic concentrator will inflate to a prescribed size and shape. This will allow solar energy to be focused and concentrated (10,000 : 1 geometric concentration ratio) enough to heat hydrogen fuel. Expansion through a nozzle will produce propulsive thrust. If 50 kw is not transferred into the hydrogen fuel, thrust will be insufficient to deliver the payload. In addition, it is imperative that there are no stray rays impinging on the trusses, torii, fuel tank, etc., that might cause catastrophic failure. We are looking for a very simple way to optically test the reflectors before they gather and focus the sun's energy into the engines. It should determine the mean pointing error to nearest 1/4 milliradian. It should determine slope error as a function of position on the concentrator. This is to enable a decision whether to go ahead or correct the problem before a failure occurs.

Solar Thermal Rocket Propulsion is the means by which solar powered propulsion systems (two energy-collecting and focusing concentrators integrated with a solar flux-absorbing thruster and using a single tank of fuel) can accomplish inter-orbital, lunar, and interplanetary transfer missions. The reflectors must always be able to track the sun and send the concentrated rays precisely into the respective thruster cavities no matter the direction of rocket travel. The foci of the concentrators will always remain in the same place on the thruster apertures, as a result of the pointing system, guidance and control intervention. The thruster is a dual cavity, dual nozzle device designed to capture the solar energy from both concentrators. The single hydrogen working fluid is heated and expanded indirectly. Hydrogen is transparent to solar flux. By conductive heating from a solar heated material in or surrounding the cavity atmosphere, we can heat the hydrogen gas. Thrust without ignition is produced in the propulsive nozzle and the exhaust gases expelled. A solar rocket doesn't carry its propulsive energy to heat the fuel on board; it receives its energy from the sun in the form of solar flux (free energy). That enables the solar rocket to use different liquid etc., as fuel. Some examples are: helium, argon, and hydrogen. Liquid hydrogen has the lowest molecular weight of all possible fuel candidates. The orbital transfer vehicle, using hydrogen as a fuel, would weigh the least.

We are looking for an innovative way to determine the quality of the collector system. We are interested in

receiving proposals on any of these related technical areas but will be able to fund only one contract on this topic.

PHASE I: Determine several methods of solving the problem and document them. Perform tradeoffs keeping the weight, volume, cost, complexity, reliability, maintainability, survivability, and deploy ability in mind. We want a system that can travel with the solar thermal rocket propulsion system into LEO on the same pallet. The OQMD test should be performed just before the concentrator system is used every orbit.

PHASE II: Choose which OQMD system best suits our needs. Perform a preliminary, then a detailed design. Finally, build the system and test it.

PHASE III DUAL USE APPLICATIONS: The alignment of optical hardware in the field is difficult. Any device which makes alignment easier will be a boon to those industries utilizing optical components in the field. The hardware and procedures resulting from this investigation will benefit these optical components manufacturers and users by improving their ability to detect, measure deviations and align optical radiation. MILITARY - The resulting hardware from this project may benefit the warfighter in the following areas. Use for target practice for determining hits or misses without using live ammunition or destroying targets; and they can be reused. Use for air combat practice instead of using live ammunition on real planes. Use as field sensors for detecting laser radiation. Use for spacecraft docking maneuvers as an alignment target. As the target for use during bombing runs. Use for feedback sensors for adaptive optics. Use for terrestrial solar power systems. Use to measure deviations for antennas, radar dishes, and radiometers. INDUSTRY - The resulting hardware from this project may benefit private industry in the following ways. As car and truck headlight alignment systems for the home auto mechanic. For spacecraft docking maneuvers as an alignment target. Use for feedback sensors for adaptive optics. Use for terrestrial solar power systems. Use to measure deviations for antennas, radar dishes, and radiometers. Use as field sensors for detecting laser radiation.

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1. Thompsen, S. Dalbey, G. Friese, E. Zaccardelli, and P. McDaniel, "Concentrator Flight Test Experiment", Technical Report No. AL-TR-90-066, Astronautics Laboratory, May 1991.
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3. Shoji, "Solar Rocket Component Study", Technical Report No. AFRPL-TR-84-057, Air Force Rocket Propulsion Laboratory, February 1985.
4. Etheridge, "Solar Rocket System Concept Analysis", Technical Report No. AFRPL-TR-79-79, Air Force Rocket Propulsion Laboratory, December 1979.
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AF98-052 TITLE: Optical Health Monitoring System for Propulsion

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop an optical health monitoring system for propulsion to facilitate non-catastrophic launch pad aborts.

DESCRIPTION: Many of today's launch vehicles utilize a combination of liquid and |strap-on| solid rockets. The scenario for launch generally is to ignite the liquid engine(s), allow them to reach stable steady-state operation, and then ignite the solids, committing the vehicle to liftoff. Even where no solids are involved, the health of the liquid propellant engine is determined by engine parameters such as chamber pressure and temperature. In some cases, the spectral emissions of the exhaust plume can provide valuable added data on the health of the engine's operation. Combining this data with on-board measurements in determining compliance with launch commit criteria would permit rapid malfunction detection and timely shutdown, preventing catastrophic on-pad engine failures. It could also potentially detect impending conditions leading to in-flight failures or underperformance, thereby permitting shutdown before launch commit and an opportunity to solve the problem.

PHASE I: In cooperation with the Air Force, research available data on: 1) the nominal prelaunch emissions spectra of current (several) liquid rocket engine fuels and 2) the spectral variations from the nominal (of the different fuels) resulting from potential engine performance problems or malfunctions. Establish preliminary go/no go limits for the spectral variations (parameters) suitable for abort/launch commit criteria. Develop a laboratory test program to measure controlled spectral variations of selected liquid fuels and associate spectral variation to known fuel (launch vehicle) deficiencies. Identify candidate optical sensors capable of discerning the variations (resulting from the fuel deficiencies).

PHASE II: Perform the test program defined in Phase I, identify/develop the required optical sensor and define a diagnostics system (with the required response time) to provide data for abort/launch commit control. Demonstrate the system on at least three engine types during government-provided launches or static test firings.

PHASE III DUAL USE APPLICATIONS: A system of this type would be useful for all types of liquid rocket engine applications, including the NASA Shuttle and commercial launch vehicles. Application to the testing of jet engines in test cells may also be feasible. In-flight applications for rockets and aircraft may also be feasible. The Phase III effort would include manufacturing, testing, and supporting use of this monitoring system for commercial applications.

REFERENCES: Chenevert, D. J., Meeks, G. R., et al., Rocket engine exhaust plume diagnostics and health monitoring/management during ground testing, IAF, International Astronautical Congress, 43rd, Washington, Aug.28-Sep 5, 1992. 11p. Report No.: IAF Paper 92-0650.

AF98-053 TITLE: Pilot Plant Production Technique for Quadricyclane

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop a technique for manufacturing quadricyclane economically in pilot plant quantities.

DESCRIPTION: Chemical additives have been developed which can be blended with existing liquid rocket propellants, especially hydrocarbon fuels, and theoretically result in performance gains in specific impulse on the order of 5 percent. These chemicals (such as methyl cubane, quadracyclane and similar compounds) have been synthesized in small amounts in the laboratory at very high cost, but not at low enough costs or in amounts sufficient to permit actual rocket engine testing. An innovative synthesis technique is needed to permit manufacture of these chemicals - not available from other sources - in quantities sufficient to perform static firing tests and verify the theoretical performance gains. If verified, this technology promises to permit significant gains in launch vehicle performance in terms of pounds to orbit. Sometimes, gains of this magnitude may make the difference between orbiting a given payload on a much less expensive existing launch vehicle, or providing an increased margin of performance.

PHASE I: Design a laboratory synthesis setup and demonstrate the ability to produce quadricyclane economically on a small scale.

PHASE II: Design and fabricate a pilot plant scale production facility, and demonstrate the capability of producing quadricyclane in pilot plant quantities at $10 per pound.

PHASE III DUAL USE APPLICATIONS: Producing large amounts of quadricyclane would economically allow it to be available for commercial launch vehicles. Additionally, quadricyclane may be applicable for increasing jet engine performance as a jet fuel additive. In jet engines, the benefits would be applicable across the military and civil/commercial aviation spectrum. Phase III efforts would include designing and fabricating an industry-scale production facility capable of producing thousand pound allotments for commercial use.

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1. Fife, D. J. Photochemical Energy Storage (Photosensitized Isomerization of Norbornadiene to Quadricyclane by Copper (I) Complexes). Doctoral Thesis, Air Force Institute of Technology, Wright Patterson AFB, OH. AFIT/CI/NR-83-66D, 1983, 205p.
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AF98-054 TITLE: Simulation Tool Development for Analysis of Acoustic Propulsion System Resonance

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Develop a flexible state-of-the-art simulation tool for acoustic propulsion system resonance analysis.

DESCRIPTION: Resonance between spacecraft thrusters and propellant feed systems significantly degrades performance. Resonance in this case refers to the acoustic coupling of the frequencies of thruster operation, either from the firing sequencing or the combustion natural frequency, with the natural frequency of the propellant feed system. This acoustic coupling can result in large pressure oscillations within the propellant feed system. These pressure oscillations directly interfere with thruster operation and may severely limit the thrust level of the propulsion system or its ability to pulse. Analysis/simulation of this phenomenon can benefit new feed system designs by determining the effects of acoustic coupling on existing feed systems and optimizing operations to limit resonance effects. The proposed simulation tool could be used as an alternative to costly system tests and drastically reduce on-orbit anomalies due to resonance effects. The analysis and resultant simulation tool shall be based on test data of various propulsion

system components and the relevant environmental effects.

PHASE I: Information necessary to determine the various effects causing resonance requires testing of the pressure wave speed variance in representative propulsion feed system components. Components such as flex lines, filters, valves, and venturis shall be tested and the variance of each measured. The Air Force shall assist in the identification/procurement of required test components. In addition, the effect of pressurant bubbles on the pressure wave speed must be measured. This will require the artificial formation of bubbles in various components and additional variance measurements. This information shall be used to develop an analytical resonance model for use in design, development and operational optimizations.

PHASE II: During this phase of the project, test data from Phase I will be incorporated into the analytical simulation model. Additional testing of combined component effects and propellant line geometry effects will be required to complete the model. The entire database will then be used to develop a flexible state-of-the-art simulation tool for analysis of acoustic propulsion system resonance. Test results of space craft configurations different than those the model is based upon shall be provided as proof of model accuracy. Code validation is established by correctly predicting spacecraft resonance characteristics seen in these engine tests.

PHASE III DUAL USE APPLICATIONS: All satellite propulsion manufacturers will benefit from use of this proposed simulation tool. The simulation tool could be used as an alternative to costly system tests and would allow designers to nearly eliminate on-orbit anomalies due to resonance effects. Existing models are insufficient for either purpose.

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AF98-055 TITLE: Advanced Integrated Systems and Devices for Space Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop and demonstrate innovative, new advanced integrated systems and specialized devices for small satellites applications.

DESCRIPTION:
Micro-Engineering Technologies for Space Applications: In the last decade, significant progress has been made in micro-engineering technologies. For space system applications, micro-engineering holds the key to revolutionize how commercial and military space systems evolve in the future. This new paradigm provides new design possibilities by enabling inexpensive replication of primitive sub-functions and direct access to many quantum mechanical phenomena. Micro-engineering is a multi-disciplinary field with design, material synthesis, micro-machining, assembly, integration and packaging of miniature 2D and 3D sensors, actuators, micro-electronics, and micro-mechanical systems. Such micro-engineering technologies can provide orders of magnitude improvement in sensitivity, accuracy, and data storage capability over conventional technology. Micro-engineering technologies of interest include: (a) Real-time Smart Vision Systems consisting of re-configurable electronics for space-based platforms supporting such applications as detection and imaging of military activity, missile warning and battle damage assessment. Having adaptable on-board processing alleviates the down-linking of massive amounts of data for post-processing. These challenges are further magnified when multi-spectral and hyper-spectral remote sensing technologies are considered; (b) Application Specific Integrated Instruments (ASIMs) can replace traditional spacecraft systems or subsystems, combine various traditional functions in new ways, or provide totally new capabilities. In most current applications, the micro-instrument is used as a local miniature "smart" sensor. The sensor acts alone with all the decisions and control relinquished to an off-board CPU. Of particular interest are ASIMs that can be mechanically or electronically reconfigured to provide new functions as required by mission needs. Such advances have the potential to revolutionize future military and commercial satellite designs.

PHASE I: Develop innovative conceptual designs of subject areas outlined above. The contractor shall address the advantages and disadvantages of each concept, device or design as appropriate. Considerations should include all hardware and software related issues, reliability, miniaturization potential and ease of operation along with satellite integration concerns as appropriate. Commercial-off-the-shelf products (COTS) should be considered and used wherever possible. Phase I should include a feasibility demonstration of the proposed concept.

PHASE II: Develop a working prototype of the system or concept as a proof-of-principle device. The contractor shall perform system analysis to determine the performance of the technology. Where appropriate candidates will be considered for demonstration on an appropriate space platform (e.g., MightySat).

PHASE III DUAL USE APPLICATIONS: The results of a successful Phase II approach would lead to further development and refinement. Potential applications of the devices and associated technologies developed by this effort include DoD, NASA, and commercial ventures. Considering the fact that the VLSI process is inherently a batch process, the development of low cost microprocessors and computers should also hold in the manufacturing of low cost and reliable micro-instruments. Picker International, a major biomedical instruments manufacturing firm, stated that miniature micro biomedical instruments has an annual sales market in excess of 1 billion. Micro-instruments for automated inspection have large markets for micro-instruments developed under this topic.

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3. S. W. Janson, H. Helvajian and E. Y. Robinson, The conceptot of Nanosatellite for Revolutionary Low Cost Space Systems, IAF No. U573.5, 44th IAF Congress, Graz, Austria, 15-22 Oct 1993.
4. Workshop of future NASA Miniature Spacecraft Technology, Feb 8-10, 1995, Jet Propulsion Laboratory, Pasadena, California, Workshop Proceedings (two volumes). Sponsored by NASA Office of Space Access and Technology.
5. P.R.K. Chetty, Satellite Technology and Its Applications, TAB Professional and Reference Books, 1991.

AF98-056 TITLE: Space Qualified Precision Deployable/Controllable Optical Support Structures

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop an on-orbit demonstration of micron-level accuracy deployment and sub-micron active control of light-weight structural components scaleable to future ten meter class space-based visible imagers.

DESCRIPTION: Continuous, or near-continuous medium resolution (< 0.5 m GRD) surveillance of future tactical theaters will require either a large number of moderate (<2.5m) aperture low Earth orbit (LEO) observing platforms or a few very large aperture (>7 m) spacecraft in orbits from geostationary (GEO) to medium altitude(MEO) circular or selected highly elliptical (HEO) orbits. The cost of a highly proliferated LEO system may prove to be prohibitive while the MEO/HEO/GEO option is fundamentally limited by current space launch weight and payload volume restrictions. One way to ameliorate the latter weight and volume limits, and to significantly reduce the cost of system deployment, is to design an imaging payload with a telescope based on sparse, or deployable primary mirror technologies. Sparse, or unfilled, aperture systems can be designed so that the full spatial resolution of a large contiguous aperture telescope can be realized with acceptable losses in light gathering power, or sensitivity. Using state of the art techniques currently under development in the Phillips Laboratory's UltraLITE Project, it will be possible to package very large erectable, or deployable imaging payloads, based upon sparse aperture concepts, within present and envisioned launch vehicle weight and volume envelopes. UltraLITE is a ground based laboratory integrated demonstration of structures, sensing and control subsystem concepts relevant to large, deployable, sparse, or filled aperture telescopes for space-based imaging of terrestrial targets. In concert with a number of related technology activities at the Phillips Laboratory, JPL and elsewhere, UltraLITE is designed to validate most of the critical enabling technologies for this future application. A key remaining unanswered question, which can only be adequately addressed in the natural space environment, is the effect of structural microdynamics, or high bandwidth, hysteretic lurching and resettling in ribs, hinges and joints, on the controllability of the structure to optical wavelength tolerances. The physical scale of the anticipated disturbances, nanometers, and their anticipated high bandwidth characteristics distinguish this phenomenon from larger scale, "macrodynamic" disturbances evaluated in previous space structures measurement and control initiatives. This Phase I effort will provide the design of a space qualified flight test article, and the fabrication of a subscale unit (not necessarily space qualified), which can be incorporated in the UltraLITE ground integration facility. The test article design must incorporate the full range of anticipated structural components, including, as appropriate, joints, plates, ribs, and tubes, and be able to demonstrate representative remote deployment and precision control functions.

PHASE I: Design of a scaleable protoflight experiment to measure and document the microdynamic (high bandwidth, sub-micrometer) environment relevant to a future space-based UltraLITE-derivative operational concept. Fabrication of one or more of the most critical elements--e.g. hinge, latch or position sensor--of the proposed test article.

PHASE II: The subscale test hardware and software will be evaluated in the UltraLITE laboratory, and a full scale flight article will be fabricated. The protoflight hardware resulting from this effort will be integrated with similar experiments and the entire test ensemble will be flown in a future flight experiment. Costs associated with hardware integration and flight are not covered under this effort.

PHASE III DUAL USE APPLICATIONS: a) Military application: Knowledge gained from performing this SBIR may result in designing and building the next generation of space based imagers, space based lasers, etc. b) Commercial/civil application: Remote

sensing data sales and services are expected to grow into a $2 billion dollar market by the beginning of the 21st Century. Since the advent of satellite remote sensing, the uses of imagery from space have evolved from more traditional applications such as meteorology, hydrology, cartography, and reconnaissance to more consumer-oriented applications such as insurance claims adjustment, marketing, real estate, and farming. The company that knows how to design and or build deployable optical systems will have the ability to utilize launch vehicles with smaller fairings resulting in substantially lower total system cost. There are two NASA missions that could utilize the technology and know how from this program. They are The Next Generation Space Telescope (NGST) program office and the Space Interferometery Mission (SIM) program office.

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2. Integrated Modeling and control of the UltraLITE system published in the 1997 IEEE Aerospace conference proceedings, IEEE catalog number 97CH36020. Authors: Lawrence Robertson, Jesse Leitner, Joseph Slator, Brett deBlonk.

3. "Assessment of large aperture lightweight imaging systems" published in the 1996 IEEE Aerospace conference proceedings. Authors: Kevin Bell, Richard Boucher, Robert Vacek, Michael Hopkins.

4. Warren, Peter A., Sub-Micron Nonlinear Shape Mechanisms of Precision Deployable Structures, Ph.D. Thesis, University of Colorado at Boulder, July 1996.

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AF98-057 TITLE: Acceleration Compensated Master Oscillator

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop a Stable Master Oscillator (STAMO) which can perform with minimum degradation in missile applications and which can also perform to high accuracy levels on-board satellites.

DESCRIPTION: The most important error source for high accuracy STAMO's is acceleration induced frequency shifting due to steady state, vibratory and shock "g" inputs. Such frequency shifts cause radars to lose track, result in errors in GPS position measurements, and can degrade frequency standards on-board satellites. The frequency shifts result from acceleration induced stresses placed on the quartz crystals used in the STAMO's. Current state-of-the-art oscillators exhibit g-sensitivities between 10-9 and 10-10 (Hz/Hz)/g. Improvements in currently obtainable performance levels by at least two orders of magnitude over a wide frequency range is necessary in order to meet projected missile performance goals and to provide very high accuracy STAMO stability in selected spacecraft applications in the presence of on-board vibrations. Responses to shock inputs of 50 to 100g must also be attenuated to levels commensurate with overall performance goals.

PHASE I: Evaluate/demonstrate design concepts for an improved STAMO capable of achieving substantially reduced acceleration sensitivities in the presence of high-g missile launch environments, vibration and shock inputs. Address all critical issues. Perform a concept demonstration and define a hardware demonstration program.

PHASE II: Demonstrate the effectiveness of the proposed design concept by evaluating the performance of several improved STAMO assemblies in the presence of shock and vibration inputs.

PHASE III DUAL USE APPLICATIONS: Improvement in STAMO performance in the presence of acceleration inputs will have application in a wide range of military and civilian uses such as (a) frequency standard for military and commercial satellites; (b) master oscillator in ground or sea-based radar systems for target missile tracking; (c) low-cost master oscillator for mobile GPS-based systems in aircraft and missiles subjected to a severe dynamic environment; (d) low-cost frequency reference for GPS aided aircraft landing systems. The demonstrated design concept must be adaptable to near production and capable of addressing a broad potential market.

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AF98-058 TITLE: Mechanically Hard, Event Recorder With Nonvolatile Memory

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop an extremely high g resistant event recorder with non-volatile, low power memory for penetrator weapon and smart fuse applications.

DESCRIPTION: At present, there are several miniature event recorders containing volatile memory that are used in instrumentation packages to sense and record impact and penetration characteristics of test projectiles and earth penetrators. These recorders operate in an overwrite mode and capture information when triggered at impact. It is necessary to retain power on the volatile memory device until the captured information is recovered. This is a satisfactory solution in most cases when recovery of the penetrator is accomplished in hours or days. In the case of some deep penetrators, recovery can take much longer, thus increasing the need for sustained battery power for a long time which increases the size and complexity of the instrumentation package. The key is the low power requirement which would allow data to be retained for long periods of time in the event that recovery was not immediate. Also, miniaturization would allow it to be carried in autos and airplanes for future crash analysis.

PHASE I: Investigate the feasibility of building a miniature, low mass recording device utilizing state of the art non-volatile memory such as EEPROM or flash memory. Survey industry and determine whether commercially available hardware exists that can survive high g (100,000 g in all directions) impact shock and rapid deceleration. The device should contain at least four channels for recording analog to digital data. Design a recorder to meet the above requirements and provide trade-off options that will minimize operating and recording power.

PHASE II: Build and test proof of principal models of the Phase I design. Demonstrate the ability to record and store characteristic data. Also demonstrate the capability to erase and rewrite data a minimum of twenty five times. Conduct laboratory tests to determine shock sensitivity and survivability of the device containing sample data. Minimum size, mass and power are of prime importance. Readout of the recorder should be accomplished with simple algorithms that can be programmed on a PC or laptop computer. Build, test and deliver a minimum of ten recorders for field evaluation.

PHASE III DUAL USE APPLICATIONS: Some military and commercial applications for a g-hardened low power memory miniature event recorder are: (a) measurement of penetrator weapon impact and penetration environment of experimental projectiles; (b) basis for development of a microprocessor for smart fuses; (c) record automobile and airplane crash impact characteristics; (d) determine value of moving vehicle safety improvements; (e) by scaling an accelerometer to the anticipated g range, this event recorder could be used for many applications where impact characteristics govern design considerations to protect an object or vehicle cargo.

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2. Experiment to Define the High-g Impact and Penetration Environment for a Smart Fuze in an Earth Penetrator. Draper Laboratory report # CSDL-P-3543. Authors: H. Chesnais, Capt A. M. Scott. Report available by contacting Draper Laboratory, 555 Technology Square, Cambridge, MA 02139. Phone: 617-258-2010; Fax: 617-258-4900.

AF98-059 TITLE: Precision-Guided Payload Decelerator/Descent and Recovery Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop reliable, GPS-guided decelerator/descent and recovery system to support space, suborbital and near-space payloads.

DESCRIPTION: Precision-guided decelerator/descent and recovery systems do not exist for high-value space, suborbital and near-space payloads. Many agencies cannot overcome obstacles such as pre-orbit launch failure, improper orbit insertion, spacecraft operational failures and lack the capability to recover high-value reusable payloads. Many space launched payloads that cannot be deorbited successfully, become space debris or risk uncontrolled reentry and possible impact into restricted, inaccessible or populated areas. During an aborted launch or launch vehicle failure, the high-value payload must endure an uncontrolled and unguided trajectory or free-fall, making it difficult to nearly impossible to successfully recover the payload intact. Standard parachutes have been used for many years to decelerate and recover many types of aerospace payloads. More recently, parawing-type decelerators with guidance systems have demonstrated improved flight and landing control systems to improve landing accuracy. Several limiting

features of these current systems include the decelerator not being able to deploy in space, or require multiple decelerator deployments to reduce the velocity. Other limitations are uncertainties in space and near-space environmental tolerance of canopy or parawing guidance and control systems. General system requirements should be adaptable or scaleable to decelerate/descend and recover a wide variety of payload types. These recovery systems will be used in a number of different vehicles, which requires a high degree of flexibility in packaging. These systems must be adaptable to land and water environments. Landing sites will include both land and water environments.

PHASE I: Identify the feasibility of an autonomous or manual guided decelerator system that is deployable from stratospheric or space vehicles. This decelerator must have the capability of being guided to a pre-selected landing site determined from the point of deployment. The initial precision is to land within a preselected 300 meter diameter circle. It is also desirable to have the capability of rapid deceleration near the surface to provide a soft landing.

PHASE II: 1) Complete/finalize decelerator and recovery system design(s). 2) Build/demonstrate full scale operational prototype of final design to mutually agreed upon Air Force specifications. 3) The Air Force will make every effort to provide a suitable launch vehicle to conduct either a dedicated or piggy-back launch demonstration.

PHASE III DUAL USE APPLICATIONS: Dual use capabilities include manned and unmanned payload abort and recovery for commercial expendable launch vehicles, manned spacecraft and space stations. Other potential uses include orbital debris capture, deorbit or removal, and microgravity experiments. Derivative uses also include high performance aircraft crew escape/recovery, airborne deployment of payloads during peacetime or hostile conflicts at diverse locations and environments. Decelerators could also support airborne delivery in response to flood, earthquakes or other natural disasters.

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4. To fall from space--Parachutes and the space program--AIAA paper 89-0926.
5. Parachute recovery location aids--AIAA Paper 86-2545.

AF98-060 TITLE: <u>Space Systems Technology Development</u>

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop an innovative method for improving performance, endurance and survivability of future space and missile systems

DESCRIPTION: Advanced Space Systems need a host of integrated technology developments in order to meet improved performance requirements. We are seeking innovative approaches and technology developments which will provide improved space system performance, endurance and survivability. The proposed approaches shall emphasize dual use technologies| that clearly offer private sector as well as military applications. Some examples of dual-use technologies include High Definition Television (HDTV), advanced communications, Energy and Environmental Conservation plus many more. Proposals emphasizing Technology Transfer will receive additional consideration. Specific Areas of interest include the following:

Space Power Systems: Approaches to high specific energy and specific power at lower cost are needed. Specifically, long life, high energy density energy storage, advanced, high efficiency solar cell designs, light weight, low volume solar arrays, and power management and distribution electronics.

Thermal Management: Advanced spacecraft thermal control technologies, in all temperature regimes are sought. Technologies for improvement include (but are not limited to): heat pipes, micromachined refrigerators and heat pumps, capillary pumped loops, integrated microelectronic cooling packages, thermal storage devices, deployable radiators, cryocoolers and cryogenic components.

Space Electronics: Innovative advanced processor, memories and digital logic components; advanced micro-electronics packaging; micro-electromechanical systems and instruments; optoelectronic, photonic and analog processing electronics are sought, particularly those that lend themselves to operation in the space environment. Candidate solutions must be radiation tolerant or leverage commercial processes to exploit radiation resistance.

Space Systems Software: Advanced concepts in expert system design, fuzzy systems, distributed expert systems, object oriented database, the integration of existing software (COTS and NDS) into an object oriented environment, and user interfaces.

Sensors: Innovations in developing ultra-violet to very long wave infrared detectors, readouts, focal planes and sensors. Innovative approaches in active sensors concepts including LIDAR, RADAR and associated signal processing, signal

conditioning, including related devices and subsystems are needed.

Space Structures: Innovative minimum weight structural concepts are needed that can withstand high-G space launch and ambient environment effects. Active and passive vibration suppression, control, advanced material applications, design and analysis methods are needed.

Astrodynamics: Innovative ideas are sought related to determination, prediction adjustment, and optimization of trajectories in space: mission analysis; space navigation and control; perturbation theories and expansions; and spacecraft attitude dynamics and estimation.

PHASE I: Further develop the concept and perform analyses required to establish the feasibility of the proposed approach.

PHASE II: Complete the Phase I design and develop a demonstrator or prototype. Document the R&D and develop a technology transition and/or insertion plan for future systems and commercial ventures.

PHASE III DUAL USE APPLICATIONS: Space systems for DoD and commercial use require advanced technology that is highly reliable, high performance, and is survivable to a variety of man made and natural environments. These technologies have immediate and definite commercialization potential in consumer goods and infrastructure improvements such as highway safety, environmental monitoring, etc.

REFERENCES: PHILLIPS LABORATORY SOFTWARE CONSIDERATIONS, ADA & ADA9X., May 4, 94. Contact Phillips Laboratory PL/VTS, 3550 Aberdeen Ave SE, Kirtland AFB, NM,87117-5776. Tele # (505) 846-0461 for copies.

AF98-061 TITLE: Multifunctional Structures for Space-Based Radar Antennas

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop and demonstrate advanced antenna RF and structures technologies for lightweight, affordable corporate-fed phased array space based radar.

DESCRIPTION: A variety of Air Force mission needs could be met by space based radar constellations, but such systems have proved unaffordable to date. Dramatic reductions in recurring costs and launch costs (through reductions in weight) could make such systems a practical alternative to existing assets, and could enable new capabilities. Recent studies have shown that low earth orbit constellations of phased array satellites, with 6 by 22 meter apertures, operating at 2000 W average RF power are the most likely candidates to achieve near term mission objectives, and be affordable. These results also indicate that the antenna weight is a significant fraction of such a satellite's weight. A significant portion of the weight is in the RF and power distribution system, the electronics enclosures, thermal control system, and the structure. Techniques to integrate or combine these functions, in so-called multifunctional structures promise significant cost reductions. A set of emerging technologies are potentially applicable, including those for lightweight packaging of RF electronics, such as T/R modules, on polyimide substrate, and the use of flex circuits which combine the packaging, thermal, structural and RF and power distribution functions. Advanced antenna processing techniques could compensate for deformations of the antenna, permitting more flexible (and lightweight) antenna structures. Digital beam-forming and DC-DC converters hardware and distributed battery systems integrated with the T/R modules could ease the problems of RF and power distribution. These technologies could also enable automated methods of fabrication, eliminating touch labor, and significantly reducing costs.

PHASE I: Explore concepts and technologies for lightweight antenna architectures. Identify weight and cost savings potentials for each, and select concepts for more detailed evaluation. Where appropriate validate key technology concepts by analysis or limited component testing. Plan the Phase II effort.

PHASE II: Develop a proof of concept prototype. Demonstrate its performance and validate the key metrics of the technologies employed. Verify by extrapolation that the cost and weight advantages will be achieved in a full system application.

PHASE III DUAL USE APPLICATIONS: Advanced capability imaging satellites have commercial potential as seen by the RadarSat venture. The technologies developed by this SBIR topic would improve the investment potential of such systems by reducing costs and improving performance. Technologies developed for radar antennas could also be employed in high bandwidth or cellular service satellite communication systems, such as DirectTV, ICO, or MobilSat. Military applications of pulse-Doppler and imaging radar in space include detection and tracking of adversarial forces and assets, monitoring of environmental conditions in a conflict zone, and assured global surveillance.

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3. Proceedings on the IEEE Aerospace Applications Conference, 9-10 February 1996, Snowmass, CO
4. Proceedings of the Antenna Applications Symposium, September 1995, Allerton Park, IL
5. Heil, Ted.; Roehrich, Bill.; Hakoupian, Jack. Advances in receiver front-end and processing components, Microwave Journal v. 40 (Jan. '97) p. 174.

AF98-062 TITLE: Smart Sensing and Information Processing

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop technologies to reduce data overload and discriminate between normal human activity and suspicious behavior.

DESCRIPTION: Currently, monitoring human behavior is a manual, error-prone, labor-intensive, and costly process. Our experience with monitoring satellites suggests that if automated tools exist that allow human operators to focus only on significant events, monitoring performance improves dramatically. We propose to develop technologies for monitoring human behavior by exception; that is, to develop tools for identifying suspicious behavior such as hazardous driving on freeways or antisocial activities on public streets.

In the last decade, significant progress has been made in both image understanding and behavior recognition. In image understanding, a large number of well-studied algorithms exist that transform data, locate edges, compute disparities along edges, estimate motion fields, and find discontinuities in depth, motion, color, and texture. Less mature, our scientific understanding of behavior recognition has come mostly from research in case-based reasoning, domain-dependent heuristics, and plan recognition.

Recently, many researchers have focused on data fusion techniques because of the large potential of combining information from disparate sources. The standard methodology used in data fusion is to combine raw or low-level data from multiple sensors, using correlation to increase belief in evidence. The drawback of this approach is that it is computationally intensive for large problems and lacks any structure that would improve scalability.

An innovative alternative is to impose an architecture that drives processing down to the lowest appropriate level and partition the problem. For example, technologies such as the silicon retina and SPRITE (signal processing right in the element) for visual sensors allows them to provide refined information from images, rather than raw data. Sensing and image processing is not enough to understand whether the viewed activities are acceptable social behavior. Fusion of the specific feature identification into information that can interpret whether a scene is normal or anomalous requires higher levels of image processing and integration.

PHASE I: Address techniques to process the visual information reliably in real time by moving much of the standard image processing tasks onto the focal plane array using silicon retina, pulse couple neural networks and signal processing right on the vision chips themselves. Having adaptable on-board processing alleviates the transmission of massive amounts of data for post-processing. Artificial intelligence technologies need to be applied to high level data to extract features from scenes that need interpretation.

PHASE II: Apply component technologies developed during phase one to prototype behavior monitoring systems in at least two different domains. Develop domain-dependent heuristics and integrate them into a behavior recognition system for identifying suspicious behavior. The ultimate system will have a person-in-the-loop, but will dramatically reduce labor costs by providing the human operator with only information that is more probably worthy of attention. We anticipate a lower error rate as a result.

PHASE III DUAL USE APPLICATIONS: These technologies will directly support the military's counter-terrorism mission by identifying, for example, explosive devices inside x-rayed packages, snipers positioned in the field, and saboteurs of government property. In addition, a massive market exists for reducing the labor associated with watching commercial surveillance cameras (e.g., stores, prisons, parking lots, airports). Robust vision sensors and data interpretation software that automatically detect and send real time warnings about in-store theft, street drug sales, violent attacks in public, unsafe driving, and auto theft are of interest.

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AF98-063 TITLE: Graphical Visualization Framework for Representing Uncertainty in Dynamic 3-Dimensional Data

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a software development framework for implementing innovative visualization techniques for representing uncertainty in dynamic 3-dimensional data.

DESCRIPTION: Uncertainty is difficult to represent for 3-dimensional and for dynamic data. For example, analyzed satellite sensor data, weather predictions, etc. contain both 3-dimensional images and an analysis based on uncertainty. Traditional methods for displaying uncertain data (scatter plots, statistical analysis, etc.) are difficult to interpret for users without training in statistics and do not work well with either 3-dimensional or dynamic data. The goal is to research new visualization techniques, new methods of abstraction, and new human computer interfaces for such data. The first step will be to design and implement a software development framework which will simplify the implementation of new visualization techniques. This framework should significantly reduce the time necessary to implement new visualization techniques, allowing new concepts to be easily tested. (Using the current state of the art in software development frameworks, the implementation time for new visualization techniques is prohibitively long.) The next step will be to build a library of visualization components that can be used to implement new visualization techniques, further reducing implementation time. The final step will be to use this framework to research and develop innovative display methods for representing uncertainty in dynamic 3-dimensional data.

PHASE I: Design an extensible architecture for the visualization framework, identify a basic set of visualization components, and implement a limited but working prototype which can be used to estimate the utility of the proposed final framework.

PHASE II: Identify a complete set of visualization components, implement the complete framework, and develop some innovative display methods to illustrate and validate the framework. Identify and obtain at least three different examples of 3-dimensional uncertain data not part of the Phase I or II research and not all from the same source. Demonstrate and validate the visualization of this data.

PHASE III DUAL USE APPLICATIONS: Visualizing uncertainty in dynamic 3-dimensional data is a general and unsolved problem. Commercial, government, and educational institutes have needs for visualizing this type data. The proposed research will be a major step towards providing a commercial product for visualizing dynamic uncertain 3-dimensional data such as weather, stock market predictions, demographics, traffic flow models, etc.

This product would also provide valuable situational awareness to the warfighter. Much of the information available during wartime is uncertain by nature. Enemy position, enemy resources, weather, satellite surveillance images, and weapon damage effectiveness analysis are examples of uncertain information. The warfighter's situational awareness will improve if s/he can understand the uncertainty of the information instead of see a simple average.

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AF98-064 TITLE: Remote Tracking

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop new low-cost, low-power remote tracking devices for Counter Terrorism, resource tracking, personal security, and other Government and commercial applications.

DESCRIPTION: Recent developments in miniaturization, low-power electronics, sensor technology, GPS receivers, etc., have made affordable, unobtrusive, virtually undetectable remote tracking devices possible. Such devices could be concealed in high-value items, or other resources whose whereabouts must be known. In some applications it will be necessary to discriminate between devices (i.e. selectively track objects).

Concepts should consider the ability to track objects covertly. Ideally devices should be individually addressable and response times short to minimize the probability of detection by unwanted individuals. This would also allow positive identification of items. Power requirements should be low to maximize battery life. Alternatives to battery power are possible. It would be desirable if the devices were small and concealable so they could be placed on objects or people without their knowledge. World wide coverage area would be necessary for military applications but not required for many civilian uses.

PHASE I: Develop preliminary tracking system design concept which identifies the required components and their performance specification, and perform a proof of concept study. Demonstrate sufficient engineering evidence to warrant continued development of the proposed approach.

PHASE II: Develop , demonstrate, and deliver a prototype tracking system based on the outcome of the Phase I study. The prototype should verify the major design elements but need not be in final form. This system should be applicable to military, law enforcement, and commercial applications.

PHASE III DUAL USE APPLICATIONS: These tracking devices can be used for both military and commercial applications in locating items such as automobiles, fleet vehicles, criminals, high-value items, space debris, weapons, explosives, etc. Military applications could include location of weapons, aircraft, tanks and other equipment. Identification of location and friend or foe would reduce the possibility of fratricide and allow commanders improved capability in positioning forces in the field. Commercial uses could include tracking of vehicles such as trucks and taxi cabs to permit more efficient routing for deliveries and pick up of items. Individual items in shipments could be located easily to lower shipping time. In the area of counter terrorism, individuals could be located covertly or material such as explosives, stolen property, and weapons could be tracked. Criminals on parole or work release could be easily located to insure compliance court orders.

REFERENCES: Lavrakas, John, Star Watch - An off-the-shelf GPS Asset Location System, ION GPS-95; Proceedings of the 8th International Technical Meeting of the Satellite Division of the Institute of Navigation, Palm Springs, CA, Sept. 12-15, 1995.

AF98-065 TITLE: Precision Latch for Deployable Optical Space Structures

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop analysis techniques and integrate a flight-qualifiable precision latch into an existing precision deployable optical structure testbed.

DESCRIPTION: Future DoD and NASA visible and infrared (IR) wavelength surveillance and astronomy missions will require large (> 4-10 m aperture), precision optical systems. For systems greater than 4 m aperture, deployable optics offer progressively increasing system weight payoffs with increasing aperture over a monolithic design. Of great concern in a precision deployable system are nonlinear effects such as hysteresis, bilinearity and microlurch that are largely dependent on joint and latch design. These effects introduce uncertainties into optical systems that ultimately limit performance. Of the two mechanisms, it is believed that latches are responsible for the majority of these unwanted effects. In this program, it is desired that a flight-qualifiable latch be developed for a specific precision deployable structure that exhibits minimal nonlinear effects and meets system load requirements. Two existing latch designs will be used as baselines to compare performance against.

PHASE I: Demonstrate by analysis and possibly through supporting test data a cohesive approach to a precision latch design that is space qualifiable. Identify a critical high-payoff subsystem technology for further development.

PHASE II: Fabricate a flight-qualifiable precision latch with minimal nonlinear effects. Demonstrate latch performance on the precision deployable testbed at Phillips Lab, and provide components for possible flight tests to be conducted by the Air Force.

PHASE III DUAL USE APPLICATIONS: Potential commercial applications and military applications center around precision deployable optical space structures. DOD applications specifically include precision deployable platforms and IR sensors. Future commercial applications may include deployable communications satellites and solar array booms. Private sector users would most likely be in the telecommunications industry.

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AF98-066 TITLE: Distributed Neural Network Processing for Smart Structures Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop a distributed parallel processing capability for implementation of neural network based identification and control in smart structures applications.

DESCRIPTION: Planned and projected spacecraft missions are requiring unprecedented accuracy in terms of precision pointing and structural stability requirements. Examples include: large sparse optical arrays, interferometers, and antenna-type structures. To maintain a high level of performance and reliability in these complex spacecraft, highly adaptable and fault tolerant control systems such as those utilizing artificial neural networks (ANN's) are required.

Recent advances in the area of neural network structural control have led to several promising demonstrations. However, similar progress is needed in the area of hardware/software development. The goal of this program is to develop processing hardware which can be easily integrated with existing actuator and sensor technology and used to implement neural identification and control algorithms. Ideally, this hardware would be small, modular, low cost, and lightweight. The ability to utilize multiple processors at different locations on the structure in a parallel processing arrangement would be highly desirable, particularly if the system exhibits fault tolerance when one or more processors fail. In addition, accompanying software tools should allow flexibility in algorithm design and minimize algorithm development effort.

PHASE I: Deliver a final report containing a trade study of available hardware/software tools and the conceptual design for implementing a neural network-based control system using distributed parallel processing.

PHASE II: Deliver a prototype system consisting of multiple distributed processors, which will be used to implement neural network based control on an Air Force structural testbed.

PHASE III DUAL-USE APPLICATIONS: This topic directly supports military spacecraft systems requiring a high degree of structural precision and stability. These include advanced imaging systems, space-based weapon systems, and systems employing high resolution antenna structures. Commercial potential exists in using the developed hardware on commercial satellite applications. In addition, the technology could be utilized in aircraft, automotive, and machinery applications. Health monitoring and control of civil structures will also utilize this technology.

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AF98-067 TITLE: Lightweight Composite Launch Vehicle Fairings With Integrated Damping

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop a methodology for the design and manufacture of payload fairing composite structures that meet strength and stiffness requirements and also incorporate damping materials.

DESCRIPTION: The acoustic environment experienced by satellites during launch is severe and in some cases can lead to damaged components or compromise of a mission. Present systems employ heavy acoustic blankets to reduce noise levels. A large fraction of the sound pressure in the enclosed volume is due to radiation from the fairing structure. Structural modes can couple to the internal acoustic field and produce unacceptably high sound pressure levels (SPL). As composite fairing or shroud structures replace built-up metallic ones, there is less inherent structural damping present. Additional damping of the fairing structure could help reduce the resonant amplification due to the structural modes, and in combination with other noise suppression techniques, reduce significantly internal SPLs. Inappropriate increase in the structural loss characteristics will not necessarily improve acoustic performance. The research should present a multidisciplinary analysis and design approach that considers structures, vibration and acoustics. The manufacturing method proposed should employ novel fabrication techniques as necessary to integrate dissimilar materials to meet the design objectives while maintaining a low per unit cost and scaleable procedures.

PHASE I: Show by analysis an approach to integrate damping material with a composite structure. Fabricate a simple composite structure and show that it has increased structural loss and improved acoustic properties.

PHASE II: Fabricate a full-scale fairing for a small launch vehicle or a large panel section for a larger launch vehicle and demonstrate by test its improved acoustic characteristics.

PHASE III DUAL USE APPLICATIONS: Potential commercial applications for this technology include all future commercial launch vehicle systems. Decreased acoustic launch environment will lead to lighter and cheaper commercial satellites of all kinds, including telecommunication, weather, monitoring and entertainment applications. Additionally, the decreased acoustic environment will lead to fewer satellite failures and, therefore, cost savings.

Potential DoD applications include all future DoD launch systems, including future reusable systems such as the Air Force Spaceplane, and all DoD launches on commercial systems. This technology will result in lighter, cheaper and more reliable DoD satellites and spacecraft, particularly those that include sensitive optics and advanced electronics on-board.

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AF98-068 TITLE: Innovations in the Fusion and Graphical Display of Real Time Heterogeneous Data

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a general architecture and innovative techniques for the fusion and graphical display of real-time heterogeneous data.

DESCRIPTION: It is difficult for a user to interpret large quantities of data at once. This can be a limitation when a combination of data might yield a bigger picture that is not apparent when the data are taken separately. For example, two different images of the same object may each have valuable information, but the combination of the two could yield new information not present in either image. Similarly, a time-sequenced set of images may illustrate subtle changes not apparent in the single images.

In addition to images, there are many other types of data that often need to be interpreted together. For example, satellite weather data and pilot reports. Military and commercial pilots often report anomalous weather. Currently, the reports are manually combined with weather data to form a more accurate report of the weather. The proposed architecture should be able to automatically combine pilot weather reports with the satellite weather information.

In the above example, the pilot reports are often only accurate for a short period. The fusion mechanism must be able to deal with dynamic real-time data, some of which may have a short lifespan.

The basic goal is to develop a computer architecture that is capable of fusing disparate types of data. Since no

programmer could possibly imagine all the different types of data, the architecture must allow new types of data and new fusion algorithms to be added. In addition, since it is not likely that all data can be fused into an easily understood format, innovative graphical visualization mechanisms will be necessary in some (if not most) situations.

PHASE I: Investigate the state of the art of information fusion and extract the generalities from existing work to create a prototype demonstrating the feasibility of an open architecture that can implement many existing fusion approaches.

PHASE II: Complete the architecture design, implement it in software, and then use the architecture to research innovative methods for performing information fusion. Identify and obtain at least three different examples of real-time heterogeneous data not part of the Phase I or II research and not all from the same source. Demonstrate and validate data fusion and graphical display using this data.

PHASE III DUAL USE APPLICATIONS: Many commercial and military information fusion problems could be solved by using the described architecture.

The most immediate military use would be in the areas of situational awareness and battlefield knowledge on demand. Many types of real-time information are available during wartime (e.g. satellite images, historical data, many types of intelligence reports). It is very difficult to fuse this data in real-time into a usable format. The described architecture would lead to better fusion mechanisms, thus providing the warfighter with better knowledge.

Commercial applications range from financial analysis to medical diagnosis. In nearly all facets of life, people are inundated with data from many sources. The proposed research would improve the state of the art for interpreting many types of data simultaneously.

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AF98-069 TITLE: Innovative Space Power Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop innovative and revolutionary components that reduce the mass and cost of space power systems while increasing their life and reliability.

DESCRIPTION: In recent years, a number of innovative components have been demonstrated that could improve the performance, cost, life, and reliability of space power systems. Some of these technologies, such as multijunction solar cells, are continuing along current technology development paths, while others, such as flywheel energy storage devices, are entirely new, revolutionary technologies.

Energy generation components shall support efficiencies greater than 30% at AM0, and/or provide more than 100 W/kg at the array (or equivalent) level. Energy storage components shall provide useable energy densities greater than 50 W-hr/kg at the cell level, for both LEO and GEO charge/discharge profiles. PMAD components shall support 70-100 V buses and 1.5-15 V payloads with efficiencies greater than 90%.

PHASE I: Develop a preliminary design of a space power system using innovative components. Analyze the performance of the system. Identify the database supporting performance and life estimates for the innovative component. Define a Phase II program that will produce a prototype of the innovative component.

PHASE II: Develop a prototype of the innovative component(s) and test the component(s) in simulated environments for both military and commercial applications.

PHASE III DUAL-USE APPLICATIONS: Any technology developed for military spacecraft can also be used in commercial spacecraft. These technologies also have wide application in terrestrial systems, such as hybrid or all electric vehicles, remote site power, building/home secondary power supplies, and power plants. The primary military application is to reduce satellite power

system mass, volume, and cost in order in increase payload mass and power budgets and reduce satellite and launch vehicle costs.

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AF98-070 TITLE: Advanced Pointing and Tracking Concepts

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Demonstrate innovative concepts for precise stabilization of optical waveforms through turbulent media, and from vibrating platforms.

DESCRIPTION: Innovative concepts leading to advanced capabilities in the area of pointing and tracking are solicited. These approaches could be useful to programs that require precise pointing and tracking capabilities, such as the Airborne Laser. The intent is to conceive and demonstrate innovative concepts for precise stabilization of optical waveforms through turbulent media, and from vibrating platforms, in order to improve the performance of airborne pointing and tracking missions. Innovation is required in areas including tracking algorithms effective over scintillated optical paths, atmospheric turbulence compensation algorithms, inertial stabilization, acoustic compensation, the innovative use of infrared focal plane arrays, high speed processing of focal plane array data, and improved testing of large scale control systems.

PHASE I: Conceptualize and design innovative pointing and tracking approaches and the demonstration that such approaches are attractive and feasible for meeting advanced Air Force requirements. This phase will demonstrate the feasibility of producing a demonstration of the advanced pointing and tracking concepts, and outline a sound set of demonstration success criteria. Design reviews will cover the individual components, the demonstration architecture, and the control concepts.

PHASE II: Demonstrate the enhanced pointing and tracking capabilities based on the approach developed in Phase I. The proposed demonstration can be either ground-based or airborne, but in either case should include the effects of both atmospheric turbulence and platform vibration. It is expected that this phase will provide valuable lessons learned for an Air Force system with requirements for precise pointing and tracking, as well as any extrapolations needed to bridge the gap between the demonstration and system environments.

PHASE III DUAL USE APPLICATIONS: It is expected that a pointing and tracking subsystem based on the concepts proposed under this research, with economical considerations folded in, would have both commercial and military applications. The military applications include all those with requirements for precise pointing and tracking through turbulent media and from vibrating platforms. The commercial market includes such areas as communication, power beaming, and surveying. It is expected that the contractor will concentrate on flexible Phase I designs to maximize commercialization potential.

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AF98-071 TITLE: Acoustic Suppression for Precision Equipment in Aircraft Interiors

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop techniques and integrate a hardware system to compensate for the detrimental effects of multiple acoustic inputs originating external to and internal to the enclosed volume of an aircraft.

DESCRIPTION: Active noise control has advanced significantly in recent years, but most applications to date have addressed physical systems with relatively limited spatial or temporal complexity. For example, noise is reduced at a single headset location or only for small numbers of sources contributing narrowband or perhaps multi-tonal input. The Airborne Laser (ABL) program represents a highly complex acoustic environment that includes multiple noise sources outside and inside the aircraft and a large number of noise and vibration sensitive precision optical components. High sound pressure levels are potentially present over a broad frequency range and performance requirements for jitter and alignment on ABL are extremely demanding and distributed over multiple components. Passive means of acoustic compensation are physically limited at low frequency and are not well suited to adapt to changes in the disturbance environment and performance demands during a typical mission. The project will employ advanced noise control techniques that can also be projected to practical automated implementation in an airborne environment with reasonable constraints on weight. The approach could include localized or distributed cancellation, equipment or machinery enclosures, feedforward and feedback control, active-passive hybrid systems, and coupled vibroacoustic considerations. The proposer should consider the differences between this development and development for noise suppression in commuter passenger aircraft and understand the realistic limits of global broadband active noise control.

PHASE I: Demonstrate by analysis and possibly through supporting test data a cohesive approach to acoustic compensation for the interior of a large aircraft with external and internal acoustic sources. Identify a critical high-payoff subsystem technology for further development.

PHASE II: Fabricate an acoustic compensation subsystem and demonstrate its ability to improve substantially the performance of a representative laboratory precision optical system under realistic acoustic amplitude input levels, frequency content, and time-variability. Demonstrate by high fidelity simulation the expected performance improvement for the aircraft environment and provide components for possible flight tests to be conducted by the Air Force.

PHASE III DUAL USE APPLICATIONS: Potential commercial applications include commercial aircraft and other vehicles, active enclosures for precision manufacturing and optical inspection equipment, and suppression of sound in high-density multi-purpose workspaces. Potential military applications include the Airborne Laser system, other vehicles incorporating precision sensors and instruments, and compensation for reduced personnel fatigue.

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AF98-072 TITLE: Isolation for Spacecraft With Multiple Payloads

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop advanced stabilization/isolation system for spacecraft that use multiple payload configurations for small launch vehicles.

DESCRIPTION: Multiple payloads are often launched on a single launch vehicle. Depending on the launch vehicle, the payloads can be stacked vertically or horizontally. In either case, there is a great deal of coupling |interaction between the payloads, adapter, launch vehicle, and the launch environment. For small class launch vehicles, the environment is extremely harsh with dynamic accelerations at the payload adapter as high at 10-20 g's. Current spacecraft are attached to the launch vehicle through a payload adapter. The adapter is hard-mounted to the spacecraft and launch vehicle and provide no isolation to the spacecraft. As a result the spacecraft must be designed and tested to very high vibration levels, which increases the life-cycle costs of many spacecraft components. The design of a spacecraft requires knowledge of structural and acoustics loads induced by the dynamic interaction with the launch vehicle. These loads are primary inertial, highly transitory, and are functions of the spacecraft, launch vehicle, and external forces. Consequently, the design process is highly interactive. For the spacecraft/adapter/ launch vehicle interface, the government desires a factor of 3 reduction in the dynamic structural borne vibration in the frequency band from 40 to 500 Hz. Also, a factor of two reduction in the dynamic interaction between the payloads is desired. The system must satisfy all requirements

imposed on current payload adapters, be compatible with launch vehicle control systems, and have minimum or no impact on payload volume and weight allowances beyond those of current payloads adapters. Proposers must be cognizant that their proposed systems will eventually have mass, volume, and power constraints. Interest or acceptance of this technology by a launch vehicle contractor is critical for demonstration or commercialization. Although not required, it is highly recommended that the small business team interface with a launch vehicle contractor in some fashion. The Phillips Laboratory will not provide industry contacts with the LV contractors. It is the small business' responsibility to develop the necessary relationships with potential industrial partners.

PHASE I: Formalize and provide supporting analysis for an innovative isolation/stabilization system for launch vehicles with multiple payloads that are vertically stacked. Proposers need to thoroughly define the problem, this includes specifications of the launch environment to be attenuated, any potential restrictions or limitations faced in the implementation of the isolation systems with the satellites manufacturers. State system level performance goals. Develop system level and component level conceptual design. Analytical and simulation results will be presented to demonstrate performance of the system.

PHASE II: Design, analyze, fabricate, and test a full-scale demonstration for evaluation. The system effectiveness will be demonstrated for representative payloads and launch vehicle configurations through critical component hardware testing coupled with additional analysis and simulation. Phase III will provide a commercial payload-launch vehicle isolator system for flight demonstration.

PHASE III DUAL USE APPLICATIONS: DoD, NASA, and commercial launch vehicle and satellite manufacturers are interested in decreasing vibration loads on satellites. In order to reduce soaring launch costs, NASA, DoD and the private sector are sending multiple payloads or satellites on a single launch vehicle whenever possible. The multiple payload approach works, but presents unique vibration isolation problems. Decreased vibration disturbances will allow the satellite manufacturers to design their spacecraft to reduced environments which will save weight, cost, and time. This technology also has potential applications in the aerospace and industrial machining industries to protect sensitive equipment from operational disturbances.

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AF98-073 TITLE: Autonomous Satellite Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop and demonstrate technologies that will result in increasingly autonomous satellite operations.

DESCRIPTION: The Air Force seeks innovative proposals to demonstrate satellite autonomy technologies. Currently, satellite operations are expensive, manual, and error-prone. Appropriate industrial engineering and advances in ground stations will undoubtedly reduce these problems, but we anticipate rapid growth in the size and complexity of the space architecture that must be supported by ground operations. Therefore, without a revolutionary change in the concept of satellite operations, we believe manual operations will continue to limit both military and commercial exploitation of space assets. Phillips Lab, with technology partners including NASA and industry, has begun a five year program to advance the state of the art and practice by funding sound research and development to automate satellite bus functions including stationkeeping, station relocation, housekeeping, and anomaly resolution. We are building on the existing base of expert-based and model-based anomaly resolution assistants; intelligent agents, executives, and execution critics; and intelligent planning and scheduling algorithms. An integrated example of the technologies we are encouraging is the Deep Space 1 intelligent agent being constructed by NASA's Jet Propulsion Laboratory and Ames Research Center. We are interested in proposals which would result in similar agents which could be generically applied to new military or commercial satellites. We are also interested in near-term solutions that automate ground-based housekeeping, especially solutions that could be easily migrated to space systems as bus processing power improves.

PHASE I: Address techniques to make satellite operations increasingly autonomous. Technologies that assist in housekeeping in such a manner as to obviate the need for regular checks initiated by ground stations are of keen interest. We are also interested in a prototype architecture that will efficiently perform task decomposition; that is, one that allows the spacecraft to decompose a task into its subtasks once it autonomously determines the primary task is required.

PHASE II: Demonstrate an autonomous satellite subsystem via computer simulation using actual, previously saved telemetry and spacecraft location data (azimuth/elevation/range). We strongly encourage reusing existing simulation technology, allowing the greatest possible exploration of satellite autonomy without concern for developing a simulation architecture.

PHASE III DUAL USE APPLICATIONS: A successful Phase II approach will result in not only a prototype autonomous subsystem but also a simulation platform for evaluating system architectures for satellite autonomy in general. Such a platform will be invaluable for determining the capabilities and cost-effectiveness of autonomy technologies before performing expensive and high-risk flight tests. The similarities between military and commercial applications will be remarkable. Military Applications include the secure management and control of future military satellites, satellite constellations and distributed satellite systems. Civilian Applications include the management and control of communication satellite systems.

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AF98-074 TITLE: GPS/INS Solution to Launch Vehicle Guidance, Navigation, Range Safety Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop low cost, reliable GPS/INS package for guidance, navigation and range safety systems.

DESCRIPTION: An ever present need exists to reduce the cost of space launches. Current guidance, navigation and range safety systems are expensive to acquire and operate. Expensive navigation grade Inertial Measurement Units (IMU's) are currently used in conjunction with the Inertial Navigation System (INS). Global Positioning System (GPS) receivers could provide the required guidance and navigation data (an approach which would greatly reduce cost) however GPS signal drop out is fairly common. The drop out problem could be solved by augmenting the GPS receiver with a low cost Inertial Navigation System (INS) composed of microelectromechanical (MEMS) produced IMU's. Such a system would not require launch pad alignment and would be orders of magnitude cheaper than current systems. Additional savings may be achieved by elimination of ground radar support to the range safety system. A target GPS/INS unit price is $1000. Up to six units would commonly be used per launch, a redundant pair a) for launch vehicle guidance, b) for spacecraft navigation and c) for range safety. In addition, the MEMS IMU's, once space qualified, could be used for attitude determination on spacecraft. The technology involved in integrating the GPS with an INS involves combining their functionality in an integrated system to provide better system performance than either one acting alone. The integration mechanism must provide a robust algorithm with ability to accommodate momentary blockage of a GPS satellite or degraded GPS performance due to poor user/satellite alignment. Issues concerned with integration of the GPS and INS systems (among others) include: 1) how best to combine GPS with INS, 2) appropriate integration architecture, 3) complexity of integration algorithms required to produce the required level of performance, 4) criteria for INS device design/selection (size/weight/cost/performance) and 5) robust filtering schemes against a) variations in the error characteristics of the individual INS or GPS units (i.e. INS drift, GPS bias, GPS dropout, etc.), b) transient events such as changes in the constellation of satellites being tracked, c) correlated measurement, and d) color or nonstationary nonwhite characteristics for both process noise and measurement noise intensity matrices. Solutions to these issues along with optimal hardware architecture are required to produce the most robust as well as cost-effective GPS/INS product. The successful contractor will be cognizant of the problems and requirements relating to current launch vehicle guidance, navigation and range safety,

PHASE I: Phase I activity shall involve: 1) development of prototype GPS/INS system hardware/software designs 2) develop/demonstrate computer simulation of GPS/INS unit operation together with analysis of system procurement/implementation/operational cost, 3) demonstrate feasibility of concept in meeting cost, weight and performance requirements.

PHASE II: PHASE II activity shall include finalization of hardware/software designs, test and evaluation of GPS/INS algorithms and production/demonstration of a prototype GPS/INS unit.

PHASE III DUAL USE APPLICATIONS: Results from this project will apply to 1) Military Applications: Missions requiring precision attitude and orbit determination (GEO and LEO satellites, and launch vehicle applications), and missile pointing/tracking accuracy enhancement (e.g. guided munitions). Military precision aircraft approaches can also benefit from this technology. 2) Civilian Applications: precision aircraft approaches (FAA applications) and use by civilian aircraft.

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AF98-075 TITLE: Variable-Resolution Simulation for Multiple Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Develop techniques to construct variable resolution simulation for multiple applications through systems acquisition cycle.

DESCRIPTION: A solution for reducing cost and eliminating redundant and inconsistent simulation is envisioned by DoD using a unified modeling and simulation framework to support the end-to-end system acquisition cycle. This simulation-based acquisition includes studies and analysis, engineering development and manufacture, test and evaluation, training and operations support. However, the current techniques employing model calibration, protocol and data standardization, and incremental patching do not provide an adequate capability to support this multiple application vision. They emphasize syntactic rather then semantic aspects of model integration. Thus the compatibility and consistency problems still remain. One of the key technologies to resolve the problems and enable the DoD vision is the variable resolution simulation. It can provide a unified framework to construct models developed at different levels of details and integrate them into a coherent and consistent family of models to support various stages in the system acquisition cycle. In addition, this technology will enhance interoperability, promote reuse of simulation, and consequently reduce development cost.

This research focuses on the development of techniques necessary for the formulation of candidate variable-resolution simulation frameworks. The emphasis are on the generic techniques of designing the correct models and identifying the attributes that can facilitate the cross-resolution interconnection, consistent representation, inclusion of operational software and hardware, and the integration of models for constructive and virtual simulation at various resolution. A prototype will be implemented to demonstrate the feasibility and evaluate the practicability of the variable resolution simulation framework developed.

PHASE I: The initial phase shall develop the required techniques necessary for at least two candidate frameworks. This will include, but not limited to, (1) the definition of consistent first and lower order effect variables, (2) the aggregation or expansion of assumptions and variables and their cause-and-effect relationship at different level of details, (3) identification of issues related to the practicality of this variable-resolution simulation, (4) assessment of alternate approaches in terms of their applicability, flexibility, and cost, and (5) detailed documentation of the techniques developed and assessment results.

PHASE II: The activity of this phase shall include (1) the development of a proof-of-concept prototype variable-resolution simulation for a specific application utilizing the techniques developed from Phase I, (2) the demonstration of this prototype's capability in support of both the architecture development of a future AF satellite control network (AFSCN) and a selected operator training function in a realistic environment by transition to different simulation resolution, (3) a driving scenario to adequately exercise the prototype, (4) validation of the consistency across different levels of resolution, (5) evaluation of the cost-effectiveness of this variable-resolution simulation framework applied to AFSCN, and (6) documentation of the design, application results, and lessons learned from the construction and use of this prototype simulation in detail.

PHASE III DUAL USE APPLICATIONS: The techniques, tools and framework developed in this research are generally applicable for both military and commercial systems acquisition. In particular, the research results can be readily applied to support the development of commercial satellite operations systems.

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3. Defense Modeling and Simulation Office, Defense and Modeling Simulation Initiative, Office of the Director, Defense Research and Engineering, Department of Defense, 1992.
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AF98-076 TITLE: Case-Based Retrieval Approach for Improving Mission Rule

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop approaches to accelerate the transformation of appropriate expert system rule sets into new mission control systems.

DESCRIPTION: The increased number and complexity of spacecraft mission telemetry measurands and the evolution of ground systems architectures that support multiple configurable roles (plug and use) have emphasized the need to alleviate the mission operator workload. Rule-based expert systems are a common technology used to manage this complexity, yet a rule set to be applied to a particular mission is often created in a stand-alone, ad hoc manner. The consequence of this is that rule-based systems are redeveloped each time the system changes. As more complex missions are planned, rule sets will grow and increase in complexity, and become more difficult to develop for new environments. This situation will slow the benefits of exploiting expert system technology. A means to leverage off the existing structure of general purpose and mission-specific rule sets needs to be developed. This problem may be addressed by applying case-based retrieval and analogical reasoning techniques to the management and assimilation of the rules themselves. Rule sets from different expert systems can be viewed as sets of cases. When viewed this way, commercial case-based retrieval (CBR) techniques can be used to assist in the knowledge representation and management of the case-base. Additionally, a means to characterize both control rule sets as well as collections of mission-specific rule sets will be needed.

PHASE I: Phase I activity shall (among other activities) 1) design an approach to a rule characterization scheme (and rule case base) based upon existing examples of current expert systems, 2) describe how the scheme can be implemented using commercial tools, and 3) provide appropriate documentation and/or simulation to show proof of concept.

PHASE II: Phase II activity shall 1) develop an advanced prototype rule structure/indexing scheme that utilizes the design approach of Phase I. This prototype will leverage off commercial tools that support case-based retrieval and on-going research in analogical reasoning strategies, 2) develop tools to facilitate transformation of existing rule-structures for use in new mission scenarios and 3) provide demonstrations of the application of the new tools to selected mission scenarios.

PHASE III DUAL USE APPLICATIONS: Tools developed to manage rule sets will have strong dual use support in areas where expert systems technology is applied in equipment monitoring environments and where the need to create new rule sets often arises such as health-care diagnosis, and industries that use or provide satellite commercial services, network management systems, and application-management systems.

REFERENCES:
1. S.E. August and L.P. McNamee, "ARIEL: A Refined Model of Analogy Understanding," Proceedings of the 4th International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, Kauai, Hawaii June 1991
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3. M. Wolverton and B. Hayes-Roth, "Retrieving Semantically Distant Analogies with Knowledge-Directed Spreading Activation," Proceedings of 12th National Conference on Artificial Intelligence, Seattle, Washington, August 1994.

AF98-077 TITLE: Adjustable, High Efficiency L-Band High Power Amplifier

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop an L-Band high power amplifier suitable for space operations on navigation and communication satellites.

DESCRIPTION: There are many tactical military and civil situations where increased received-signal strength from space-based satellites would reduce signal acquisition time and enhance overall user receiver set performance. As space-based solar cell power systems degrade significantly in time, satellite systems are sized for a low end-of-life-power (EOLP). Excess beginning-of-life-power (BOLP) is normally shunted and dissipated as heat. Use of this excess power capability in terms of higher radiated RF signal power has been hindered due to poor amplifier efficiencies when the amplifier was required to operate over large variable output power ranges. These inefficiencies also impact the thermal design of the satellite. Major programs such as GPS would reap substantial

benefits if BOLP excess power were used to supply higher radiated RF signal power. With launch rates on the order of three to four per year, a significant portion of the constellation would be at the beginning-of-life phase resulting in a higher signal strength to end users. For GPS, the amplifier would have to be a light-weight, have a long-life and be capable of surviving both natural and man-made radiation. Current Block IIF L-Band performance requirements could be used as a design starting point. A multiphase effort is suggested as outlines below.

PHASE I: Phase I activity shall concern: 1) Air Force assisted requirements definition, 2) development of a preliminary design of a L-band high power amplifier, capable of operation over a large variable output power range, and 3) demonstration of critical amplifier components performance, e.g., output RF transistor performance.

PHASE II: Phase II activity shall concern: 1) final L-band amplifier design, 2) production prototype build and demonstration of the RF amplifier over a large variable output power range.

PHASE III DUAL USE APPLICATIONS: Commercial communication satellites would similarly benefit from the new architecture. Commercial systems such as Iridium may be able to use the excess power for higher reliability in their communications, just as the military will benefit from its implementation into GPS satellites.

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1. Seymour, C.C., Development of spacecraft solid-state high power L-Band amplifiers, Journal: IEEE Proceedings F (Communications, Radar and Signal Processing) vol. 133 no.4, p326-38, July 1986.
2. Eisen, E.L, et al. 10kW L-Band Amplifier Tubes for Efficient and Reliable Troposcatter Communication Transmitter Systems Final Report from Contract F30602-83-C-0149, by Varian Associates.
3. Whittaker, N., et al. Design of a Linear L-Band High Power Amplifier for Mobile Communication Satellites, In JPL, California Inst. of Tech., 2nd International Mobile Satellite Conference (Imsc 1990) p 384-389.
4. Goux, P.R., High Power Bi-directional Coupler for Space Applications, RF Design, vol. 14, no. 5.
5. Kondo, K. et al. Design and Performance of transponder on ETS-V for Mobile Communications Experiments, Transactions of the Institute of Electronics, Information and Communication Engineers B-II. vol. J72B-II no. 7. p. 343-50.

AF98-078 TITLE: Broad Tuning Range VCXO for Space Clock Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop a broad tuning range precision voltage-controlled quartz-crystal oscillator (VCXO) for space applications, suitable for an atomic frequency standard.

DESCRIPTION: High precision voltage-controlled quartz-crystal oscillators (VCXO) are used pervasively on board military, scientific and commercial spacecraft to maintain frequency control and as system clocks. Even in navigation and communication systems requiring the time and frequency accuracy provided by atomic clocks, a VCXO is used as the atomic clock local oscillator. As the crystal oscillator ages, its frequency changes slowly with time; in order to maintain the VCXO output frequency at its set point, its control voltage must be adjusted to compensate for this aging effect. Crystal oscillators on board spacecraft will age through the full mission duration, even if they are not powered during some fraction of the time; thus, VCXO frequency aging rate and tuning range jointly limit mission duration, and adding VCXO redundancy will not remove that limitation. In general, the wider the tuning range of a crystal oscillator, the harder is it to maintain high frequency stability. As an example, if a VCXO is to maintain a relative frequency stability of one part in 1012 over a certain time interval, and it has a relative frequency tuning range of a part in 107, then the crystal's load reactance must be stable to a part in 105 during the same interval, under the full range of operating conditions. This is difficult to accomplish because the crystal's load reactance is affected by stray capacitances and inductances, by the stability of the tuning varactor capacitance vs. voltage characteristic, and by the stability of the varactor voltage. For many specific space applications, currently available VCXO tuning ranges will not reliably support missions longer than about ten years. The restrictions on VCXO tuning range are imposed by the oscillator tuning circuit, and not by the crystal resonator itself. Thus, the restriction on tuning ranges could be relaxed by developing new, possibly more complex tuning schemes (e.g., coarse/fine tuning), enabling significantly longer VCXO mission lifetimes. Successful Phase I proposals should demonstrate familiarity with spacecraft precision VCXO requirements and a thorough understanding of the current state-of-the-art.

PHASE I: Develop and test prototype, high stability, broad tuning range crystal oscillator tuning circuits. Select and demonstrate best circuit.

PHASE II: Using selected circuit, build and test a space-qualifiable, broad tuning range precision VCXO to mutually agreed upon Air Force specifications.

PHASE III DUAL USE APPLICATIONS: A space-qualifiable precision VCXO having a broad tuning range would be in demand for many DoD, NASA and commercial space applications requiring precision timekeeping and/or frequency control, and long spacecraft lifetimes. Navigation and communication satellite systems, both military and civilian, are clear examples of such applications.

REFERENCES: Vig, John R., Quartz Crystal Resonators and Oscillators For Frequency Control and Timing Applications, SLCET-TR-88-1 (Rev 5.2), U.S. Army Electronics Technology and Devices Laboratory (LABCOM), Ft. Monmouth, NJ, 1992.

AF98-079 TITLE: Multi-level Modeling and Simulation Techniques for Electronic Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Develop a multi-level modeling and simulation capability for systems analysis and design.

DESCRIPTION: Current simulation tools for electronic systems focus on only a single level of modeling abstraction. Tools for behavioral simulation do not allow access to detailed models of hardware components that ultimately will be used to implement systems. It is the non-ideal behavior of various hardware components that may ultimately limit performance. There is often a need to model certain critical hardware components as they behave in an overall system design. This calls for a heterogeneous modeling technique that can model the overall system at a behavioral, or idealized level, with more detailed modeling of certain selected portions of the system. One example of the non-ideal behavior that might be modeled is intermodulation distortion in non-linear RF circuitry. There are many tools for modeling RF hardware, but an end-to-end system level simulation is not practical within such tools due to the complexity of the representation traditionally used at the hardware modeling level. What is needed is an approach that allows various portions of a system design to be modeled at different levels of abstraction. Different levels of system modeling abstraction usually involve different techniques for model representation and solution. A continuous-time dynamical system might be represented by a set of coupled differential equations. Traditional system-level tools solve the differential equations by approximation with finite-differences. Circuit-level tools like SPICE (Simulation Program with Integrated Circuit Emphasis) solve the differential equations with an iterative solution technique that is more accurate, but more time consuming. An environment is needed which can support a mixture of representation and solution techniques. Techniques to be considered for this effort would include discrete-event simulation, continuous-time simulation, and RF and circuit-level simulation. A focus of the effort will be the integration of the various modeling techniques. A useful modeling and simulation tool should use graphical techniques for problem setup and results analysis to the extent possible. Novel graphical techniques or combinations of graphical techniques will be explored. The use of system description languages such as A-VHDL (Analog VHSIC Hardware Description Language), MHDL (Microwave Hardware Description Language), or SPICE related models would be desirable.

PHASE I: 1) Develop detailed design/documentation for a multi-level modeling and simulation capability. 2) A simple prototype of the combination of modeling/simulation techniques shall be demonstrated as proof of concept for Phase II development. 3) The Phase I effort shall result in a detailed plan for Phase II.

PHASE II: Develop a full working prototype of the multi-level modeling/simulation capability. The Phase II effort will result in a system that is ready for full-scale commercial development.

PHASE III DUAL USE APPLICATIONS: Development of a multi-level modeling and simulation capability would benefit all electronic systems development, whether for commercial or military use. Telecommunications and satellite systems are just a few examples of areas where both commercial and military systems would benefit from an enhanced modeling and simulation capability.

REFERENCES: Simulation of Communication Systems, Jeruchim, Balaban and Shanmugan, 1992, Plenum Press, New York.

AF98-080 TITLE: Very High Efficiency DC-DC Converter Development

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop and demonstrate an efficient power converter with power forms consistent with emerging commercial and military bus standards.

DESCRIPTION: Existing space qualified power converters are designed to be most efficient at five volts with the efficiency declining as the secondary voltage drops. A need exists to expand the technology in order to develop innovative, reliable, efficient DC-DC converters for future trends of lower power electronic components (1.0 V | 3.3V). The converter should address the

challenges of 1) operating from a high voltage regulated DC primary bus and 2) providing a suitably regulated secondary voltage over a range of loads and temperatures. Additionally, the challenge exists for meeting the power requirements for the space environment needs, including radiation environments associated with a long term space mission. The technical challenge is to maintain the reliability and efficiency while balancing the selection of component types and number of components for a producible device.

The following information captures the existing trends for future space needs for DC-DC converters (the information represents the range of possible design goals):

1. Output power range: 300W to 1000W.
2. Efficiency: (90% at 3.3V output and 100V input.
3. Output voltage options: 1.0V, 2.5V, 3.3V.
4. Input voltage options: 50V (+0.75/-1.5V); 70V (+1/-2V); 100V (+1.5/-3V).
5. Radiation tolerance: Consistent with military satellite strategic radiation guidelines for 15 year MMD.
6. Minimum load to maintain regulation: none.
7. Load regulation: 0.5% or nominal output voltage.
8. EMC: Consistent with bus specification.
9. Output ripple voltage: (1% of peak to peak at nominal voltage.
10. Soft start time: 1 to 5 ms.
11. Inrush current: Less than 2X maximum steady state input current following `On command. Rate of rise: (1 amp per millisecond.
12. Input undervoltage protection: (15% below min. bus voltage with turnon (10% over max. bus voltage for 50V, 70V and 100V.
13. Input overvoltage: Survive without overstress an overvoltage of 10% over max. bus voltage.
14. Output overvoltage: Latchoff converter if output voltage is (20% over maximum nominal voltage. Command |ON| to reset latch.

PHASE I: Refine requirements in cooperation with the Air Force. Develop an innovative power circuit topology based upon the requirements. Design control electronics to accommodate the range of load, regulation and bandwidth requirements derived from the goals listed above and prepare a functional block diagram identifying control circuit partitions. Validate the design by simulating the response to a full range of thermal, and loading effects, including primary and secondary voltage transients for the range of primary and secondary voltages provided. Deliverables shall include all schematics, block diagrams, and data from simulations in addition to periodic status reports and a final Scientific and Technical Report.

PHASE II: Construct a prototype of the power converter that is as small, light and reliable as possible. Test the power converter over the range of voltages and loads. Deliverables shall include the power converter prototype and test documentation in addition to periodic status reports and a final Scientific and Technical Report.

PHASE III DUAL USE APPLICATIONS: Power management is also a primary concern for DoD spacecraft as higher performance electronics tend toward lower voltages. Currently there is a gap in products available to meet the space environment requirements for these future low power devices. Other commercial applications for power converter devices include automobiles, aircraft, commercial communications, and spacecraft. In particular, automobiles are expected to phase in high voltage buses eventually creating a market exceeding $100 million per year for power conversion technologies that could benefit from this effort. Power conversion efficiency improvements will also provide a significant environmental benefit.

REFERENCES: Switch Mode Power Converters, Sum, K., Marcel Dekker, Inc 1984.

AF98-081 TITLE: Advanced Lightweight Structures for High Frequency Antennas

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Demonstrate the benefits and feasibility of advanced structures technologies for high frequency antennas.

DESCRIPTION: Growing cost restrictions on advanced military, as well as commercial, space communication systems are driving designers to significantly reduce weight and volume of spacecraft to enable launch on smaller, less expensive, launch vehicles. For communication satellites, antenna size is typically a driving parameter, but stringent surface accuracy requirements for high frequency applications are in conflict with weight and volume reduction efforts. Several promising technologies for ultra-lightweight antennas, now offer the potential for dramatic improvements in the weight, volume, and cost of next generation, high frequency communication systems. Advanced reflector concepts include thin skin composite antennas with little or no backup structure that can provide not only weight benefits but can also be packaged in very small volumes. Similarly, inflatable reflectors, such as that recently flown by NASA, have displayed potentially beneficial practical application, provided technical challenges in the area of self repair and reductions in the make-up gas system can be resolved. For phased array applications, advancements in composite materials could enable the development of high thermal conductivity, low dielectric constant antenna support structures. Similarly, low cost,

lightweight wave guides could be manufactured integral to the phased array antenna panel structure using composites. Each of these technologies, while promising, currently has significant risks that must be addressed through further development and demonstration prior to consideration for practical application. In particular, the ability to meet anticipated surface accuracy specifications must be characterized. A project aimed at delineating the advantages and disadvantages of the various approaches, and selecting and demonstrating a high payoff technology is urgently required.

PHASE I: 1) Conduct a critical assessment of promising antenna technologies relative to both the state-of-the-art and other, higher risk concepts. 2) Identify the potential impact on parameters such as weight and cost through appropriate analysis and simulation. 3) Delineate the primary technical challenges facing various technologies, and assess the feasibility and timeline necessary for practical application. 4) Select one or two concepts for further development and demonstration and document/demonstrate the basis for selection.

PHASE II: Demonstrate the feasibility of the technology identified in Phase I. Tasks shall include, but not be limited to, a detailed analysis of the performance of the technology, test demonstration of key technical parameters at a subscale level, and justifiable predictions of performance, manufacturability, and cost. The result of this phase shall be a proof of feasibility technical demonstration, together with convincing documentation, of the value of the concept.

PHASE III DUAL USE APPLICATIONS: Military operations rely heavily on satellite communications for protected mode services, high capacity services and mobile services. Advanced lightweight, high capacity antennas are critical to meeting these requirements. The commercial space industry is based on cost effective communication satellites. As such, there is a potentially large market for advanced, cost/weight effective, antenna structures. There is also the possibility of cross fertilization to other areas, such as lightweight solar array concepts.

REFERENCES:
1. Development of Flight Hardware for Large, Inflatable-Deployable Antenna Experiment, Freeland, R. E. et.al. IAF, International Astronautical Congress, 46th Oslo, Norway, October 2, 1995.
2. Antenna Mechanical Technologies within ESA, Reibaldi, G. G., Proceedings of the Second ESA Workshop on Mechanical Technologies for Antennas, 1986.
3. Shape Control of Inflatable Reflectors, Utku, S. et.al., Journal of Intelligent Materials Systems and Structures, Vol 6, Issue 4, July 1995.

AF98-082 TITLE: Next Generation Spacecraft Bus Structures

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop advanced structures technologies for weight and cost reduction in next generation spacecraft buses.

DESCRIPTION: Growing cost restrictions on advanced military, as well as commercial, space systems demand greater efficiency in spacecraft subsystems to provide higher payload mass fractions. Spacecraft structures have typically been viewed as essential but unproductive components of satellites. Developing technologies now provide the opportunity to revolutionize the efficiency of spacecraft structures and provide necessary weight savings for next generation systems. Current concepts ranging from low cost, lightweight composite fasteners to embedded electrical wiring offer distinct benefits. A focused development of one or two of these high risk, high payoff concepts could have a significant impact on future military and commercial space systems. Technologies that could be considered include: lightweight composite joints, attachments, or fasteners for box to panel connections; multifunctional structures that integrate mechanical, thermal, and even electrical functions into a single entity; polyimide panels with embedded fiber optics for a light weight distribution and connector system; a busless satellite in which all spacecraft and some payload elements would be integral to an essential element such as a solar panel; and the concept of using composite fibers as integral electrical conductors, eliminating the need for harnesses. Each of these technologies, while having potential weight and/or cost benefits, currently has significant uncertainties and technical challenges that require a focused development and demonstration program.

PHASE I: Conduct a critical assessment of promising structures/materials technologies relative to both the state-of-the-art and other, higher risk innovative concepts. Identify the potential impact on critical parameters such as weight, cost, and reliability. Delineate primary technical challenges facing various technologies, and assess the feasibility and timeline necessary for practical application. Select concepts for further development and demonstration. The primary result of Phase I shall be a well defined Phase II development and demonstration plan for a technology with potentially high payoff for military space communication systems.

PHASE II: Demonstrate the feasibility of the technology(s) identified in Phase I. Tasks shall include, but not be limited to, a detailed analysis of the performance of the technology, detailed demonstration of key technical parameters (at a subscale level) to mutually agreed upon (Air Force and contractor) specifications and documented analysis of performance,

manufacturability, and cost.

PHASE III DUAL USE APPLICATIONS: The subject technologies are applicable to nearly all types of space systems, and would be attractive to commercial space industries, especially in the communication area. As such, there is a potentially large market for advanced bus structures. There is also the possibility of cross fertilization to other areas, such as aircraft. The dual-use potential of this technology is therefore judged to be high.

REFERENCES: DiNardo, M., Zweben, C., Kreitz, J., Lightweight Composite Electronics Enclosure for High Stress and Temperature Environments, 35th International SAMPE Symposium, April, 1990.

AF98-083 TITLE: Very High Efficiency Solar Cell

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop a very high efficiency solar cell through the technology of Tri/Quad-Junctions and/or graded-bandgap material systems.

DESCRIPTION: Develop a monolithic or mechanically stacked triple or quadruple junction solar cell with electrical performance efficiency greater than and cost/weight per unit cell less than, present day dual-junction space solar cells. The approach may also include usage of graded-bandgap material systems to support or replace additional junctions.

PHASE I: Develop advanced solar cell conceptual designs. Select two or three designs for further development. Conduct Modeling Studies and Perform Materials and Processing Feasibility Investigation on selected cell designs. Fabricate preliminary, unoptimized cell designs and demonstrate concept feasibility. Identify cell design(s) for further development in Phase II.

PHASE II: Finalize design/material selection for cell design(s) identified in Phase I. Finalize basic manufacturing process and produce prototype cells. Demonstrate prototype cell performance in comparison to current cell designs.

PHASE III DUAL USE APPLICATIONS: Civilian and Commercial Satellites would benefit from: 1) specific power and power density enhancements gained due to increased solar cell efficiencies, and 2) from decreased solar array area and weight for a given power.

REFERENCES:
1. Design of High Efficiency Monolithic Stacked Multijunction Solar Cells, Photo Voltaic Specialist Conference (PVSC-13), pp. 886-891.
2. Performance Losses in High-Efficiency Monolithic Multijunction Solar Cells. PVSC-14, pp. 346-350.
3. A Theoretical Analysis of the Optimum Number of Units in Multigap Multijunction System Under Various Operating Conditions, PVSC-15, pp. 383-386.

AF98-084 TITLE: Automated Contamination Control for Space-based Sensors

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop practical approaches for maintaining or recovering sensor performance when key optical surfaces are contaminated.

DESCRIPTION: Molecular and particulate contamination can seriously affect the performance of space-based sensors. This contamination can come from the environment, nearby vehicles, hypervelocity debris generated contamination and the sensor platform itself. Vacuum conditions often cause material to outgas, with these products likely to condense on cold surfaces such as the optics and detectors. Solar radiation can then polymerize certain contaminant layers into a tenacious gel. Besides obscuring targets and reducing detection range, this allows more out-of-axis light to be scattered onto the focal plane, and increases the cooling load for sensors operating in the infrared wave bands. The overall impact of this contamination is decreased sensor performance, shortened mission lifetime, and higher replacement/launch costs.

PHASE I: Develop detailed contamination prevention and removal concepts suitable for use on space-based sensors. Develop a prototype design of a contamination control system. Fabricate/demonstrate selected system components to provide proof of feasibility of the approach being developed.

PHASE II: Design, fabricate, and demonstrate (to mutually agreed upon specifications) a production prototype contamination detection- removal/collection system suitable for use in a lightweight optical sensor.

PHASE III DUAL USE APPLICATIONS: The low-impact contamination control system could find immediate use in both military and civilian space programs. Industrial fields such as micro-electronics manufacturing could use them to isolate and prevent contamination that plays a critical role in process yield.

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1. National Orbital Environment guidelines for Use In Aerospace Vehicle Development, NASA Tech Memo 4527, June 1994.
2. SPIE Vol. 2261, Optical System Contamination; Effects, Measurement, and Control IV (1994).
3. Mittal, K. L. (Editor), Treatise on Clean Surface Technology Volume, Plenum Press, New York, 1987.

AF98-085 TITLE: Distributed, Embedded Structural Monitoring Sensor Networks for Spacecraft/Solid Propellant

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop non-invasive sensor nodes for health determination at various points within spacecraft/solid propellant.

DESCRIPTION: Current electronics systems health and status monitoring in spacecraft and launch vehicles is virtually decades behind that of the industrial sectors. Methods of obtaining and processing parameters of interest (temperature, pressure, strain, humidity, etc.) are bulky, granular (limited number of measurement points), or inaccurate. Signal distribution and telemetry is done with large amounts of heavy cabling and connectors. Current practice does not involve embedding intelligent stress/strain sensors within propellant or remote, confined locations. Current sensors suffer from errors due to drift, temperature changes, and mechanical interaction with surrounding materials. The advent of ruggedized low power microelectronics, micro-electro-mechanical systems (MEMS) fiber optics, and advanced packaging provide exciting new possibilities in distributed architectures for health and status monitoring in spacecraft/spacelift platforms. Through ruggedized packaging methods, such as hermetic spray coatings, chip-on-flex, and substrateless packaging, it is possible to consider embedding advanced electronics and sensors at locations in spacecraft, propellant and launch vehicles, which were previously prohibited. Consideration can also involve distributed networks of hundreds of very compact (postage stamp size) intelligent data gathering centers capable of autonomous operation. MEMS, advanced packaging and fiber optics allow for significant reductions in size, weight, and power of sensors, associated electronics and cabling. Innovative approaches are required for improving the state-of-the-art in embeddable spacecraft and spacelift vehicle structure and propellant system health and status monitoring. Offerors should give strong consideration to the combination of enabling technologies to achieve hundred fold reductions of the size weight and power consumption of sensor/processor/telemetry nodes. Offerors must address the qualification of these devices according to their specific operating environments and system reliability requirements. It is especially important that the effects of the environment (e.g., temperature, radiation, and corrosion) are compensated for to maximize long-term output stability.

PHASE I: Design specific sensor concepts and define viable system architectures. Detailed conceptual designs of micropower, ruggedized sensor/processor combinations compensated for thermal and environmental variation shall be developed together with feasibility demonstrations of selected concepts.

PHASE II: Demonstrate multiple transducers and associated processing nodes. All features of the network and operation of the nodes within the architecture must be shown in a qualifiable, producible form. Improvements over conventional approaches must be quantified and demonstrated.

PHASE III DUAL USE APPLICATIONS: Since distributed monitoring systems have already created applications in the commercial sector (e.g., biological implants, shipping containers, buildings, amusement park rides), the commercial application potential of the advanced concepts which will result from this project will be pervasive. For example, safety-critical structures, such as boilers or amusement park rides, could be covered with hundreds of miniature sensor nodes. When mechanical stress, temperature, vibration, etc. exceeded a critical parameter, system shutdown could be assured before danger to human life could present itself. Such a technology might assist in the design of optimal prototypes since lots of information on many distributed monitoring points could be used to gain a continuum picture of overall system performance.

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2. Helvajian, Henry (editor) Microengineering Technology for Space Systems, Aerospace report ATR-95(8168)-2, 30 Sep 1995. For information on obtaining a copy, contact Dr. Helvajian at (310) 336-7621.

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AF98-086 TITLE: Autonomous Message Routing Algorithms

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop near-optimal algorithms for packet-switched routing of messages within a multiple satellite constellation.

DESCRIPTION: In a low or medium earth orbit constellation each satellite has limited connectivity to a ground station. In order to maintain timely telemetry and mission data, messages can be routed via crosslinks from one satellite in the constellation which does not have current access to a ground station to another satellite in the constellation which does have current access to a ground station. The optimum path for such a message is dependent on the relative positions of the satellites and ground stations and the crosslink connectivity. An algorithm to determine the optimal routing would be NP-complete (equivalent to the traveling salesman problem) and consume an inordinate amount of processing resources and time. The goal of this project is to develop a heuristic near-optimal algorithm that can be used independently by each satellite in the constellation, which does not consume a large amount of processing resources or time, and guarantees that each message reaches its destination in a reasonable amount of time.

PHASE I: Perform a literature search of relevant algorithms and select candidate algorithms for further analysis/development. A set of evaluation criteria shall be developed to compare algorithms, such as implementation efficiency, repeatability, etc. The properties of the candidate algorithms shall be analyzed according to the evaluation criteria and the most promising will be prototyped. The contractor shall develop/demonstrate a computer simulation (using a commercial off-the-shelf network analysis tool) to analyze the link connectivity for a low to medium earth orbit constellation.

PHASE II: Analyze, improve, finalize demonstrate, and document the behavior of the prototyped algorithms for (Air Force specified) satellite constellations using appropriate DoD directed computer simulation tools.

PHASE III DUAL USE APPLICATIONS: Develop Commercial Off-the-Shelf (COTS) software implementing the selected algorithms robust enough for military satellite applications. Such packet-switched routing algorithms are applicable to any low to medium earth orbit commercial communications satellite constellations (e.g., Teledesic, Iridium).

REFERENCES:
1. Sidi, M., Segall, A., Failsafe Distributed Optimal Routing in Data-Communication Networks, MIT Lab for Information and Decision Systems, Report: LIDS-R-890,Mar 79, 155p. NTIS: AD- A068 138/7.
2. Brayer, K., Adaptive networking of variable topology satellite networks, International Conference on Digital Satellite Communications, 6th, Phoenix, AZ, Sept 19-23, 1983, Proceedings (A85-15451 04-32). New York, Institute of Electrical and Electronics Engineers, 1983, p. VIII-14 to VIII-20. Available from AIAA Tech Library.
3. Mathis, A. E., Denny, B., et al., Network Reconstitution Protocol, Rome Report No.: SRI-5453; RADC-TR-87-38. NTIS No.: AD-A184 755/7/XAB.

AF98-088 TITLE: Low Power Radiation-Hardened Analog Electronics

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop methods to apply emerging concepts in advanced electronics packaging to systems with high-performance analog components.

DESCRIPTION: Recent developments in advanced packaging of digital electronics systems indicate that dramatic increases in component densities are needed for tomorrow's space systems. Analog systems will undoubtedly follow the same trends. At the highest densities, however, the packaging techniques used for digital systems (for example, wafer scale integration) may prove inadequate for analog systems, which (among other issues) may require special consideration of higher noise sensitivities and continuous time-dependent (non-discrete) behavior.

PHASE I: Address solutions to the size, weight, power, and performance requirements of future advanced spaceborne systems, with the primary focus on analog system applications. Conceptual high density analog packaging concepts shall be developed and demonstrated to provide proof of concept feasibility.

PHASE II: Construct a low-power, high-performance miniature analog system shall be constructed in cooperation/coordination with Air Force needs. This system will take advantage of the research performed in Phase I and provide an operational demonstration in accord with Air Force/contractor agreed upon specifications.

PHASE III DUAL USE APPLICATIONS: Reliable, cost effective, technology relating to increased component densities of digital and analog electronics systems will be of intense interest for both DoD and commercial space-based and terrestrial electronic systems.

REFERENCES:
1. McDonald, J. F. et al. "Multilevel Interconnections for Wafer Scale Integration," Journal of Vacuum Science and Technology, A 4(6):3127-3138 (1986).
2. Alexander, David R. et al. Design Issues for Radiation Tolerant Microcircuits in Space, NSREC Short Course, 1996.
3. Williams, Jim (ed.) Analog Circuit Design|, Butterworth-Heinemann Boston MA 1991.

AF98-089 TITLE: Long Life, Fault Tolerant, Spacecraft Sensor Gimbal/Bearing System

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop ten year life, high reliability, ultra-smooth, fault tolerant, gimbal for slow scan sensors.

DESCRIPTION: Increasing pointing accuracy, lifetime requirements, extended environmental survivability, and other operational requirements (sensor scan rate, settling time energy/weight/vibration reduction) will eventually exceed the performance capabilities of current sensor gimbal systems. Electromechanical gimbal systems currently in use display mechanical wear, vibration, require lubricants, and have limited life. As payload functions expand the need for precise, vibration free sensor gimbal functionality and reliability increases. Current limitations are partly due to the materials, components, and processes that were developed over a decade ago. An innovative, fault tolerant sensor gimbal design (including application of reliable, low-friction bearings and lubricants, if required) is needed to provide more accurate, reliable and cost effective space based sensor gimbal mounts for DoD/NASA/commercial payloads. The recent advances in electromagnetic suspension technology portend an alternative to electromechanical designs in the area of satellite sensor gimbal mounting. Typical two axis sensor gimbal systems are required to handle inertial loads of 5-6 IN-Lb-S2 in elevation, and 15-16 In-Lb-S2 in azimuth, be capable of active travel of +/- 185o in azimuth and -1o to +81o in elevation at an acceleration rate of 2R/S2@2R/S for each axis. Positioning error should be less than 0.005 degrees. Operational life is at least ten years. Power requirements are in the range of 3.2 Amp (Max) for the elevation axis and 1.7 Amp (Max) for the azimuth axis. Friction torque should not exceed 3 In-Lb for the elevation axis and 8 In-Lb for the azimuth axis. Structural stiffness must be capable of supporting an error signal commensurate with a 40 Hz Servo. Operational temperature span is minus forty to plus one hundred seventy degrees Fahrenheit. Materials from which the gimbal assembly is fabricated must not display outgassing characteristics greater than 1 percent total weight loss and 0.1 percent volatile condensable materials in a vacuum of 1X10-5 torr or less. The resulting two axis gimbal system must include a lock down launch mechanism capable of withstanding 15 g's launch vibration for a period of 3 minutes. A two axis gimbal mount design capable of meeting the above criteria should be capable of being up sized or down sized to meet additional application requirements. Successful proposals will demonstrate a thorough knowledge of the current state-of-the-art in satellite sensor gimbal designs and requirements.

PHASE I: 1) Through cooperation with the USAF, develop a thorough understanding of current satellite sensor gimbal designs versus future requirements, 2) develop preliminary two axis gimbal design, complete with documentation that will provide proof of functionality, 3) produce/demonstrate small breadboard operational prototype| to ensure proof of basic design concept.

PHASE II: 1) Complete/finalize two axis gimbal design, 2) build/demonstrate full scale operational prototype of final design to mutually agreed upon Air Force specifications.

PHASE III DUAL USE APPLICATIONS: Development of a long life, vibration/maintenance free, operationally reliable sensor gimbal mount will have high DoD/NASA/Commercial demand for use with spacecraft sensors, air and ground based radar, and communication antenna applications and security surveillance equipment.

REFERENCES:
1. "Application of Superconducting Bearings and Dampers", Mechanical Technology Inc., 16 Sept 1991.
2. Williams, R., Wayner, P., Ebert, J., Fedigan, S., Reliable, High-Speed Digital Control for Magnetic Bearings, Proceedings Fourth International Symposium on Magnetic Bearings, August 1994, ETH Zurich, pp. 1-6.
3. Ohishi, T., Okada, Y., Dejima, K., Analysis and Design of a Concentrated Wound Stator for Synchronous-Type Levitated Motor, Proceedings Fourth International Symposium on Magnetic Bearings, August 1994, ETH Zurich, pp. 201-206.

AF98-090 TITLE: Micro-Sensors for In-Situ Rolling Element Bearing Temperature and/or Pressure Measurement

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop micro-sensors for long term sensing of rolling element bearing temperature and/or vapor pressure.

DESCRIPTION: This solicitation concerns the development of a new generation of long lasting, wear resistant, micro temperature and/or vapor pressure sensors for space based rolling element bearing applications. In-situ and remote sensing (radio telemetry) approaches are sought, in addition to other approaches. The primary cause of space based rolling element bearing failure is lack of lubrication. Earliest warning of insufficient lubrication is indicated by temperature and/or vapor pressure rise at the rolling element to race contact area and rolling element to separator pocket interface. Widely used approaches in monitoring rolling element bearing health involve measuring temperature variation of the outer race or bearing housing and/or increase in operational vibration. However, due to the thermal lag involved, these temperature techniques commonly fail in predicting timely onset of lubricant interruption, when measures could be taken to prevent occurrence of catastrophic failure. It has been determined that by measuring the temperature and/or vapor pressure variation in close proximity to the rolling element to race contact area of a bearing, the onset of insufficient lubrication failure can be determined in a manner timely enough that the system can switch to remedial systems before catastrophic failure occurs. Long lasting and wear resistant micro sensors are sought to measure the in-situ temperature and/or vapor pressure of lubricated contacts (within a rolling element bearing) using active and remote sensing approaches. These measurements are desired to be minimally invasive, be located in an area that will minimize thermal and/or vapor pressure response time and operate in the presence of liquid or grease lubricant, in atmospheric or vacuum environment. Such approaches may include (among others) thin film micro sensor technologies, miniaturization of existing telemetry techniques and data and signal processing. Due to extreme weight/size requirements, the sensor and data and signal processing units, whether direct or remote sensing, must be extremely small and light weight and be capable of ten year operational life.

PHASE I: Conduct preliminary analysis, design and development of suitable micro-sensor(s). Design(s) should include operational hardware/software/data processing requirements and provide laboratory demonstration and testing of selected micro-sensor concepts. Phase I effort shall result in selection of a micro-sensor design for Phase II prototype development/demonstration.

PHASE II: Finalize development and engineering of the selected micro-sensor package for reliable, long term wear resistant application to space based rolling element bearings. The contractor shall provide full scale demonstrations (hardware/software/data processing capability) of the production prototype micro-sensor package operational capability when applied to Air Force designated rolling element bearings.

PHASE III DUAL USE APPLICATIONS: The micro-sensor and technology developed under this program will have civilian and military applications. Remote and active micro-sensing of temperature and/or vapor pressure in space based rolling element bearings has applicability to military and commercial satellite systems as well as gas turbine engine technology. There is also a large market in the commercial bearing, seal and automotive industries.

REFERENCES:

1. P. N. Cutchis, A. F. Hogrefe, J. C. Lesho, The Ingestible Thermal Monitoring System, Johns Hopkins APL Technical, Volume 9, Number l, Pages 16-21, 1988.
2. R. W. Burrahm, J. K. Davis, W. D. Perry, A. DeLos Santos, Development of a Piston Temperature Telemetry System, SAE Paper 920232, 1992.
3. W. H. Ko, Power Sources for Implant Telemetry and Simulation Systems, in a Handbook on Biotelemetry and Radio Tracking, C. J. Amalaner and D. W. MacDonald, Editors, Pergamon Press, 1980.

AF98-091 TITLE: Thermal Management for Advanced Electronics

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop innovative thermal management technologies for future large, wafer scale, space-based integrated circuits.

DESCRIPTION: Future space-based electronics systems will require innovative packaging solutions to enable space systems to meet size, weight, and power requirements. Commonly, these approaches are based on efficient 2-D and 3-D arrangements of electronics, often involving "multi-chip modules" (MCMs). As chips are brought closer together, the area/volume power density (and, therefore, heat) increases. It, is conceivable that (unaided) densities of advanced packaging will be such that the resulting heat generated during operation cannot be removed fast enough with conventional heat-sinking schemes to sustain an equilibrium. Two solutions are

possible: (1) use extremely dense electronics only in systems which require steady-state operation for SHORT periods of time, or (2) use non-conventional heat removal techniques. The former solution is not acceptable for any space systems that must operate for more than a few minutes. Therefore, it is necessary to consider new heat removal approaches which are tractable for the unique problems of space systems, where within the interior of spacecraft, conductive heat transport mechanisms are virtually the only viable solution for any significant removal of heat. Innovative solutions are sought for this problem: examples to consider include micro-encapsulated, integral, direct liquid cooling systems, heat pipes, and anisotropically conductive substrates among others. Although technology dependent assumptions may impact a solution (e.g., all-CMOS), emphasis should be placed upon innovative mechanisms that result in the removal of the required amount of heat.

PHASE I: Evaluate/develop conceptual designs for techniques that can provide significant thermal management improvements compared to the thermal management techniques used in packaging approaches. Proof of concept demonstrations shall be conducted to indicate the practicality of such techniques for use in military and space systems.

PHASE II: A functional system shall be constructed which shall demonstrate the ability to remove high amounts of heat (the exact amounts will be established based primarily on Phase I analyses). The demonstrated system must be capable of operation under severe thermal, mechanical, and radiation environments. Furthermore, the constructed system shall demonstrate the feasibility of heat removal by simulating the electrical power loading of "typical" electronic systems and then demonstrating thermal equilibrium of this system in operation.

PHASE III DUAL USE APPLICATIONS: The thermal management techniques, will find commercial application in projects of interest to government, industry and academia, especially with respect to commercial space applications. The unique thermal boundary conditions of the space environment do not permit solutions widely used in terrestrial applications such as air cooling. It is also possible in certain circumstances to find applications in other domains, where large amounts of dense circuitry can be confined with limited air flow boundary conditions.

REFERENCES:
1. Bar-Cohen, A. et al. Advances in Thermal Modeling of Electronics Components and Systems. New York: ASME Press, 1990. (1986).
2. Moresco, Larry L. "Electronic System Packaging: The Search for Manufacturing the Optimum in a Sea of Constraints" IEEE Transactions on Components, Hybrids, and Manufacturing Technology: 13(3), September 1990.

AF98-092 TITLE: Ultra-Low-Power Semiconductor for Multi-Chip Modules

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop advanced packaging technology, low power/high component density, semiconductor electronic systems for space application.

DESCRIPTION: The trend in electronics at the component and system level is for ever more increasing density. As electronics devices get smaller, they consume less power, but since they are smaller, more of them can be fit into a unit area, and hence the power consumed by an integrated circuit does not necessarily decrease with time. With the advent of two-dimensional multi-chip modules (MCMs), and the increasing interest in three-dimensional MCMs, the power density of a system in area and volume is expected to grow dramatically. Heat density goes up at approximately the same rate as the power density goes up, hence thermal management becomes a paramount factor. Potential solutions include (1) the introduction of various apparatuses to improve the heat removal ability of as-built electronics and (2) lowering the power (and heat generation) of the electronic components. While much attention is beginning to be placed on the first approach, relatively little attention has been placed on the reduction of power in electronic components themselves, other than that which comes about naturally through feature size reduction. If semiconductor components/logic devices were built (utilizing an existing process) that consumed five to ten times less power, then the dissipated heat generated would be reduced by a similar factor. The need, therefore, is for innovative solutions that go beyond increased heat removal of as built electronics, yet minimize the impact on existing semiconductor fabrication processes. On a system level, where millions of such devices would be employed, the savings translates into improved size and weight (and therefore cost) due to the reduction of power and heat. In some cases, these ultra-low power devices would enable systems to be built which were previously inconceivable due simply to the inability to place all of the components within proximity due to the heat dissipation problem.

With space systems, furthermore, comes the added complexity of the space radiation environment. Low voltage processes may find that threshold voltage shifts and device leakage currents may render ordinarily low power design approaches useless. Packaging strategies, such as "tightly coupled MCMs" can provide an architecture where components are united in a controlled impedance environment. Drivers between components can exploit the significantly reduced capacitance and inductance as compared to printed

wiring boards. Additional structures and functions can be introduced for level shifting, mitigation of simultaneous switching noise, threshold voltage stabilization (by exploiting body effect of field effect transistors), etc., in a manner transparent to a system designer.

PHASE I: Analyze, design, and test electronic components/devices which generate significantly less heat than comparable current devices. The basis/proof of concept for lower power devices that achieve approximate density parity to devices built in the current state-of-the art must be clearly established.

PHASE II: Demonstrate systems constructed to prove that ultra-low power, high component density device technology is possible. The Phase II systems shall be compared against conventional versions of the same systems to fully quantify the advantages of the proposed approach.

PHASE III DUAL USE APPLICATIONS: Electronic components displaying the attributes of ultra-low power and high component density, commensurate with current operability characteristics, will be in high demand for practically all DoD/NASA/commercial electronic systems.

REFERENCES: Proceeding of 1994 International Workshop on Low Power Design, April 24-27, 1994, sponsored by IEEE and ACM-SIGDA, Napa, CA

AF98-093 TITLE: Advanced Thermal Control Coatings

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop and prove advanced material coatings for the control of spacecraft thermal systems.

DESCRIPTION: Improvements in materials and coatings on spacecraft thermal management systems may lead to significant gains in efficient rejection, absorption and distribution of heat aboard spacecraft. Increasing thermal flux densities associated with High Density/High Power Electronics and smaller spacecraft designs must be addressed through highly reliable, low cost, increased efficiency coatings. Advanced materials with electrochromic properties capable of rapidly modulated optical properties through application of a small electric potential may serve in the capacity of mechanical spacecraft louvers at significant savings in weight, complexity and reliability. New thermal control coatings are sought to advance the state of the art in solar reflectors, solar absorbers, flat reflectors and flat absorbers. Coating advancements sought for spacecraft thermal management include: improvements to emissivity and absorptance characteristics, improvements in manufacturability, ease of coating application, lower costs and Increased coating lifetimes through reduced sensitivity to charged particles, ultraviolet radiation, high vacuum and contamination. Variable emittance coatings, Thin Films for IR Modulation, Polymer-Laminate Devices for IR Modulation may all have application for tight temperature control while minimizing heater power requirements commonly in use. Additional technologies including improved emmisivity and/or absorptivity coatings for both passive and active thermal control surfaces may include electrochromic, thin film, polymer-laminate, plasma spray and other materials.

PHASE I: Phase I activity shall include (among other issues): 1) A through review of material science knowledge of new materials and their applications to improved and/or variable property coatings for spacecraft thermal management systems; 2) Design and/or integration/identification/application of specific coating systems capable of: a) increasing radiator or spacecraft body heat rejection, and b) practical application of variable emissivity/absorptance coatings for active modulation of thermal/optical properties; and 3) limited demonstration of selected coating systems to provide proof of feasibility.

PHASE II: Phase II activity shall include (among other issues): 1) Final development of the selected coating system (identified in Phase I) including coating, application techniques, temperature control system, etc.; 2) A production prototype demonstration of the coating system applied to prototypical, current spacecraft thermal control surfaces; and 3) provide adequate data for government/Air Force to accomplish comparative cost/efficiency analyses of the new coating system against their current thermal management systems.

PHASE III DUAL USE APPLICATIONS: Variable emissivity coatings are not only applicable to advanced DoD/NASA/commercial space craft but also to home and commercial dwellings where control of thermal surfaces can dramatically decrease heating and air-conditioning costs. In addition, reduced infrared signature coatings may be applicable to civilian law-enforcement operations requiring decreased likelihood of nighttime detection.

REFERENCES:
1. Rosenfeld, J. H., Anderson, W. G., et al., Space power thermal management materials and fabrication technologies for commercial use, Journal: AIP Conference Proceedings No. 324, Pt 2, p. 893-901, 1995.
2. Hurley, C. J., Lehn, W. L., Long Duration Exposure Facility M0003-5 Thermal Control Coatings on DoD Flight Experiment, NASA Report Sep 92, 38p. NTIS No.: N93-12782/7/XAB.

AF98-094 TITLE: Spacecraft Thermal Management

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop innovative technology for assuring long term thermal management of spacecraft

DESCRIPTION: The purpose of this topic is to solicit innovative designs for thermal management systems and/or components applicable to advanced space craft. In addition to thermal management, design criteria shall include: 1) reduced space craft size, weight and power and 2) increased performance and reliability. The technologies advanced shall include both passive and active cooling mechanisms effective over a broad operating temperature range. Specific areas of interest include, but are not limited to: 1) Heat transport using such technologies as: fixed and/or variable conductive heat pipes and/or capillary pumped loop components with associated single/multiple phase mediums; 2) Heat dissipation utilizing such technologies as: lightweight and/or deployable radiators, including any advanced materials applications; and 3) Innovative thermal integration technologies including cryogenic devices such as thermal storage switches and thermal storage devices. The contractor shall formulate system and/or component designs, comparative (to current systems) analysis and detailed system and/or component integration plans. Technology required for insertion of the component(s) into existing space craft thermal management system(s) and/or insertion of a new thermal management system, shall be addressed in the plan. Insertion plans shall note advantages/limitations of the proposed systems/components in relation to space mission/environmental requirements.

PHASE I: Develop conceptual designs of advanced thermal management systems (thermal bus) and/or components, from which designs shall be selected (based upon a structured evaluation analysis) and preliminary prototype designs constructed. The evaluation analysis shall document (among other criteria) thermodynamic characteristics, materials of construction, interface requirements, development status, comparative thermal efficiency, comparative cost and life-limiting mechanisms. Proof of concept demonstrations shall be provided to assure feasibility.

PHASE II: Finalize designs and construct a working prototype of the component(s)and/or system. A full scale demonstration shall be conducted in compliance to a mutually agreed(contractor and Government) specification. Utilizing demonstration produced data, the contractor shall perform/document a complete system analysis to determine the performance of the new technology in comparison to established thermal management component(s)/systems. Issues for comparative analysis (among others) include power, mass, volume, temperatures, efficiency, cost and manufacturability.

PHASE III DUAL USE APPLICATIONS: In view of general smaller satellite requirements (for cooling more high-power, more dense electronics with less costly, lighter weight, and more reliable systems) the potential market for a successful thermal management system is quite large for both the military (DoD), civilian (NASA) and commercial satellite industries. Potential commercial applications of the thermal management component(s)/system and associated technologies developed by this effort include communications and weather satellites and terrestrial thermal management systems, including co-generation applications, and residential, commercial and industrial heating and air conditioning.

REFERENCES:
1. Juhasz, A. J., Rovang, R. D., Carbon-Carbon Heat Pipe Testing and Evaluation, Presented at the 29th Intersociety Energy Conversion Engineering Conference, Monterey, CA 7-12 Aug 1994, NTIS No.: N94-37318/0/XAB.
2. Persson, J., Liquid Droplet Radiator: Status of Development, 4th European Symposium on Space Environmental Control Systems, Volume 2, p.747-752. NTIS No. N92-26969/5/XAB.
3. Held, J., Hauser, J., New Thermal Components to Control High Density Heat Transfer, NASA Sponsor. In Esa, 4th European Symposium on Space Environmental Control Systems, Volume 1, p.593-598. NTIS No.: N92-25908/4/XAB.

AF98-095 TITLE: Vibration Isolation of Launch Vehicle Payloads

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop total satellite isolation system meeting all requirements of the specified launch vehicle standard interface.

DESCRIPTION: This solicitation concerns the need for a vibration isolation system which meets total payload requirements. The proposed isolation system must address several key issues: 1)interface with the launch vehicle (LV) attitude control system to assure acceptable integration, 2)adherence to all environmental restrictions (rattlespace, height, weight, volume, etc.) imposed on the standard payload attachment fittings and 3)ability to pass all required couple loads analysis. The isolation systems may be a passive or a passive/active hybrid system which provides a minimum of 2:1 RMS reduction in transmitted loads above 10 Hz (use of a frequency which will not conflict with LV attitude control system is mandatory). System design methodology should allow for the

development of a common vibration isolation package which can accommodate the spectrum of satellites intended for use on a specific launch vehicle. Systems should be modular where ever possible to allow for minimum changes to the standard baseline in order to meet mission requirements. Although industry participation is not a requirement, proposers are encouraged to seek industry partners to allow for successful transition of the technology under PHASE III.

PHASE I: Phase I activities shall include (among others): 1)analysis of existing and predicted payload and launch environments; 2)develop familiarity with LV standard payload interfaces 3)develop conceptual designs for payload vibration isolation systems and 4)select most promising conceptual design from which a prototype design shall be developed for an Air Force specified launch vehicle.

PHASE II: In Phase II: 1)the selected vibration isolation system design shall be finalized, 2) a prototype system shall be constructed and 3) a full scale demonstration shall be conducted in compliance with Air Force specifications.

PHASE III DUAL USE APPLICATIONS: Successful vibration isolation technologies/systems derived as a result of this development program will have high potential for application to many DoD/NASA/commercial launch vehicles and their respective payloads.

REFERENCES:

1. Lee-Glauser, Gina and Ahmadi, Goodarz, Vibration isolation of launch vehicle payload and its subsystem, Journal of Aerospace Engineering, v8 n1, Jan 1995, p 1-8.

2. Thampi, S. K., Le, D. N., Wilke, P. S., Soft-Ride to Orbit: Viscoelastic treatments for launch load attenuation, AIAA/ASME/ASCE/AHS Structures, Structural Dynamics & Materials Conference - Collection of Technical Papers v2 1995, AIAA, New York, NY, p 829-839.

AF98-096 TITLE: Maintaining Cleanliness of Large, Previously Cleaned, Components During Transportation

CATEGORY: EXPLORATORY DEVELOPMENT; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop process to maintain cleanliness of large, previously cleaned, components from manufacturer to launch site

DESCRIPTION: Following the manufacture of large launch vehicle and spacecraft related structures (payload fairings, payload adapters, etc.), specified cleaning and inspection activities occur to insure spacecraft sensors are not contaminated by residue and dust remaining on these structures. Currently, the majority of these cleaning/inspection activities take place at launch bases, instead of at the manufacturer's plant, because of the inability to cost-effectively transport large structures in a manner that will maintain the cleanliness required for spacecraft application. The focus of this solicitation is to develop environmentally acceptable packaging and transportation methods that can meet spacecraft cleanliness requirements. Large component cleanliness requirements include 1) freedom from particles visible to the unaided eye (except for vision corrected to 20-20), with a 100-125 ft-candle light at a distance of 6 to 18 inches and 2) non-volatile residue left on the surfaces must not exceed 1.0 mg/ft2. In addition, packaging material requirements include limits on material out-gassing and dust generation.

PHASE I: Conduct a critical assessment of current Air Force packaging and transportation methods. Identify alternative environmentally acceptable cleaning, packaging and transportation processes, with special emphasis on low outgassing materials/systems. Delineate primary technical challenges facing various technologies, and assess the feasibility and timeline necessary for practical application. Select concepts for further development and demonstration. Develop cost models for cleaning, packaging and transportation of typical large structures and compare to current, similar activities promising structures/materials technologies relative to both the state-of-the-art and other, higher risk innovative concepts.

PHASE II: 1) Develop a typical large structural component (representative payload adapter or fairing sector) as a test article; 2) manufacture, clean and inspect this component to required cleanliness levels; 3) package and transport this component over the road for at least 1000 mi.; 4) unpack and reinspect this component to verify required cleanliness levels have been maintained; 5) document the process and recommend cost reducing improvements.

PHASE III DUAL USE APPLICATIONS: The subject technologies are applicable to nearly all types of space systems and launch vehicle components, and would be attractive to commercial space industries, especially in the communication area. There is also the possibility of cross fertilization to other areas, such as aircraft. The dual-use potential of this technology is therefore judged to be high.

REFERENCES: Ledous, F. N., Bibliography: Codes, standards, procedures, specifications and reports relating to contamination control, Report NO.: NASA-TM-X-63982; X-723-70-220. Documents available from AIAA Technical Library and NTIS.

AF98-097 TITLE: Electromagnetic Effects, Measurements, Protection, Sources, and Satellite Protection

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop high power electromagnetic or Radio Frequency (RF) sources, measurement techniques, protection, and new methods for addressing threat phenomena to satellites.

DESCRIPTION: The Phillips Laboratory is in need of new and innovative approaches in the development and demonstration of compact, lightweight, RF sources for both weapons and commercial applications. The technology sought should address sources capable of delivering gigawatt levels of power in microsecond or shorter pulses. Both narrow and wide band sources are of interest. The technologies that may be addressed in this effort include pulsed power, high power microwave tubes, transmission lines, mode converters, and antennas. Also of interest are methods and techniques for measuring the performance of these components, the effects that such environments will have on electronic systems, and methods of protecting systems from electromagnetic environments over a wide range of frequencies and field levels. Protection against electromagnetic effects is becoming critical with the increased use of electronics, lower power semiconductors with reduced noise immunity thresholds, reduced shielding through increased use of plastics and composite materials, and increased RF emissions from commercial and military radiators. The increased use of Commercial-Off-The-Shelf (COTS) equipment in military systems will also require improved protection approaches to effectively use COTS without major redesign and expense. Application of electromagnetic technologies for other areas such as security systems, law enforcement, medicine , and information systems are also of interest. In addition to the application of electromagnetic protection to satellites, additional protection is needed for other threat environments such as radiation, thruster firings, space debris, orbit dependent chemical reactions with naturally occurring species, and solar or laser radiation. Many of these environments are natural or occur during normal operations, but others may be threats faced by satellites during a war time situation. Reliance on commercial satellites for future military functions is likely to increase and reliable, survivable satellites are a must for both peace time and possible war time conditions. Additional technologies of interest include high energy plasma production, measurement, and applications.

PHASE I: Feasibility experiments and demonstrations will be conducted. A proposed schedule for implementing the proposed approach, specific commercial applications, and possible market partners will be included in the final report. Commercial partners committed to Phase II support is desired.

PHASE II: Develop and implement the Phase I approach or preliminary design, producing a prototype model, device, and/or process which must be demonstrated to be effective either at full operation or scaled to laboratory bench parameters. Prototypes developed during Phase II will be delivered to the PL in operating order with sufficient documentation to allow for validation testing. Identification and commitment of commercial partners (if not accomplished in Phase I) shall be pursued. A viable private sector marketing approach must be developed and implemented.

PHASE III DUAL USE APPLICATIONS: Many of the necessary technologies required for military weapons systems have similar commercial applications. High power sources and antennas can be used to locate and identify buried unexploded ordinance needed in base clean up efforts. Other technologies associated with ultra wide band sources can be used to improve airport and other security systems operating at lower power levels commensurate with personnel safety. Protection of future electronic systems is a must in a society with ever increasing dependency on reliable operation of automobiles with airbag, anti-skid brakes, electronic transmissions and steering, and engine control. Fly-by-wire aircraft, information highway systems, and home appliances are among other systems critically dependent on reliable operation of electronic subsystems. Increased use and dependency on satellites for everything from communications, global positioning systems for both military and commercial aircraft, weather information, and many other applications combined with the high cost and difficulty of repair require that these systems be designed to protect them from threat environments both during normal operation and in case of war time to protect our interests in the world of the future.

REFERENCES: W.L. Baker, Air Force High-Power Microwave Technology Program, Aircraft Survivability, published by the Joint Technical Coordinating Group/Aircraft Survivability, Arlington, VA, Fall 1995.

AF98-098 TITLE: Vacuum High-Power Microwave Load

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop a vacuum, high-power microwave load capable of handling 3.5 GW, 1.0 ms pulses for 1.15 GHz < frequency < 1.35 GHz.

DESCRIPTION: The USAF Phillips Laboratory has been developing multi-gigawatt, narrowband high power microwave sources

at L-band frequencies for a number of years. The two sources of current interest are the MILO [Ref. 3] and the RKO [Ref. 4]. For both of these high power microwave tubes, the power is extracted into evacuated 28.575-cm inside-diameter circular waveguide, propagates in the TM01 mode, and is then radiated into an anechoic chamber using a suitable antenna system. The goal of this SBIR effort is to be able to eliminate the need for an antenna and anechoic chamber through the use of an evacuated high power microwave load capable of handling pulses with power levels of at least 3.5 GW and of 1.0 ms duration. This will allow experiments on the tube physics to be conducted without the substantial cost in both space and money of an anechoic chamber.

PHASE I: Investigate the possible design approaches and feasibility of developing a vacuum high power microwave load capable of providing a return loss of -20 dB or less for the TM01 mode propagating in a 28.575-cm inside-diameter circular waveguide for the frequency range of 1.15 GHz< frequency< 1.35 GHz. The load should be able to handle single-shot pulses (one pulse every 15 minutes) with power levels of at least 3.5 GW and of 1.0 ms duration. An external power density leakage from the load of no more than 4.0 mW/cm2 is required, and it must have a base pressure < 1.0'10-6 Torr. Evaluate novel load concepts capable of sustaining the extremely high surface electric fields without breakdown. A proposed schedule for implementing the proposed approach, specific commercial applications, and possible market partners will be included in the final report.

PHASE II: Develop and implement the Phase I approach, producing an engineering prototype model of the vacuum high power microwave load. In addition, research and develop innovative concepts to extend the Phase I approach to the repetitively-pulsed regime. Specifically, it must be capable of providing a return loss of -20 dB or less for the TM01 mode propagating in a 28.575-cm inside-diameter circular waveguide for the frequency range of 1.15 GHz< frequency < 1.35 GHz. It should be able to handle burst-mode operation (100 Hz for 1 second with 15 minutes between bursts) with each pulse having a power level of at least 3.5 GW and a pulse duration of 1.0 ms. An external power density leakage from the load of no more than 4.0 mW/cm2 is required, and it must have a base pressure < 1.0x10-6 Torr. Prototypes developed during Phase II will be delivered to the Phillips Laboratory in operating order with sufficient documentation to allow for validation testing. Identification and commitment of commercial partners shall be pursued. A viable private sector marketing approach must be developed and implemented.

PHASE III DUAL USE APPLICATIONS: High power microwave source development researchers at the USAF Phillips Laboratory and at the US Naval Research Laboratory have a pressing need for gigawatt-level microwave loads. This will allow experiments on the tube physics to be conducted without the substantial cost in both space and money of an anechoic chamber. The civilian sector has a similar need for vacuum high power microwave load technology. Since the load design can be scaled to other frequencies, it can be used for testing high power microwave sources used in very high power radars, for the next-generation linear colliders in high energy physics, and for rf heating of tokamaks in plasma physics.

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1. L. Earley et al., Comprehensive approach for diagnosing intense single-pulse microwave sources, Rev. Sci. Instrum., vol. 57, pp.2283-2293, 1986.
2. C. Montgomery, Technique of Microwave Measurements. New York: McGraw-Hill, 1947.
3. S. Calico et al., Experimental and theoretical investigations of a magnetically insulated line oscillator (MILO), Proc. SPIE, vol. 2557, pp. 50-59, 1995.
4. K. Hendricks et al., Extraction of 1 GW of rf power from an injection locked Relativistic Klystron Oscillator,Phys. Rev. Lett., vol. 76, pp. 154-157, 1996.

AF98-099 TITLE: High Power Triggered Gas Switches

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop new concepts and enhanced capabilities in very high power, very fast, triggered gas switches for ultrawide band (UWB) transient microwave sources.

DESCRIPTION: High power, high voltage gas switches are an integral part of the development of pulsed power technology for narrow band and ultrawide band electromagnetic sources. The Air Force is interested in new innovative concepts and techniques for accurately triggering fast (10pS to 250pS), high voltage gas switches (500kV to 1MV with a dV/dt up to 10*16 V/s) for a variety of potential applications.

The ability to accurately trigger very fast UWB sources will enhance their capability. Risetimes of 10 pS to 250 pS are commonly produced with current UWB technology. For satisfactory synchronization of a source pulse with other fast events, triggering jitters of 10% of the risetime (1-25 pS) are desired.

PHASE I: Demonstrate promising techniques for triggering very fast gas switches which will have application to the Phillips Laboratory's UWB electromagnetic technology program. Basic feasibility of the proposed techniques will be

investigated to determine the specific approaches and to identify critical development requirements and potential risks.

PHASE II: Develop and fabricate a prototype system, conduct laboratory, and other tests which will demonstrate a capability with clear commercial potential. Develop commercial partnership interests for a Phase III production and marketing program.

PHASE III DUAL USE APPLICATIONS: The Air Force and other military services have needs for this fast switching technology for application in transient radar for target location and discrimination, both above and below ground, and for interference testing of military equipment. The civilian sector has similar requirements for triggering UWB energy. Potential commercial applications include weather radars, communications, sub-glacial geological surveying, structure evaluation for bridges and buildings, and locating and identifying buried objects, pipes, tunnels.

REFERENCES:

1. W.L. Baker, Air Force High-Power Microwave Technology Program, Aircraft Survivability, published by the Joint Technical Coordinating Group/Aircraft Survivability, Arlington VA, Fall 1995.
2. Ultrawide Band Sources and Antennas -- Present Technology, Future Challenges, A. Stone, C. Baum, L. Carin, (eds), Ultra Wideband/Short-Pulse Electromagnetics 3, Plenum Press, New York, 1997.

AF98-100 TITLE: Neutralization of Chemical/Biological Agents

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop technology for the production, packaging, or triggering of nuclear spin isomers for denaturing and/or neutralizing chemical/biological agents.

DESCRIPTION: Excited metastable nuclear states called spin isomers offer the potential for storing very large amounts of energy at high energy density. Certain spin isomers offer a high energy density material that is second only to fission and fusion fuels in terms of energy density. The Phillips Laboratory is in need of new and innovative approaches in the development and demonstration of methods for the production and triggering of nuclear spin isomers such as 178 Hf m2 for use in denaturing or neutralization of hazardous chemical and/or biological agents and for other purposes. Innovative and economical ways of producing spin isomers in sufficient quantities for commercial, law enforcement and military use are desired. Methods of effectively and reliably triggering the isomers to release intense bursts of high energy gamma radiation are crucial for the successful development of this technology.

PHASE I: Feasibility experiments and demonstrations in one of the areas above will be conducted. A proposed schedule for implementing the proposed approach, specific commercial applications, and possible market partners will be included in the final report. Commercial partners committed to Phase II support are desired.

PHASE II: Develop and implement the Phase I approach or preliminary design, producing a prototype device, system and/or process which must be demonstrated to be effective either at full operation or scaled to laboratory bench parameters. Prototypes developed during Phase II will be delivered to the PL in operating order with sufficient documentation to allow for validation testing. Identification and commitment of commercial partners (if not accomplished in Phase I) shall be pursued. A viable private sector marketing approach must be developed and implemented.

PHASE III DUAL USE APPLICATIONS: Many of the necessary technologies required for military weapons systems have similar commercial/law enforcement applications. Nuclear isomers can be used to neutralize or denature biological or chemical military weapons, and they can also be used by law enforcement authorities against weapons devised by terrorists. The technology also has application for the neutralization of various types of hazardous waste and dangerous biological hazards.

REFERENCES:

1. C. B. Collins and J. J. Carroll, Laser Physics 5, 209-230 (1995).
2. H. Roberts, J. Hyperfine Interactions (in press 1997).
3. F. J. Agee, J. Hyperfine Interactions (in press 1997).
4. C. B. Collins, C. D. Eberhard, J. W. Glesner, and J. A. Anderson, Phys. Rev. 37, 2267, (1988).
5. Yu. T Oganessian and S. A. Karamian, J. Hyperfine Interactions (in press 1997).

AF98-101 TITLE: High Power Microwave Antennas and Mode Converters

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop new concepts and enhanced capabilities in Very High Power Narrowband, Wideband and Ultrawide Band electromagnetic energy mode conversion and transmission.

DESCRIPTION: High Power Microwave emitters for narrow band and wideband microwave energy as well as ultrawide band electromagnetic transients are of interest for a variety of potential applications that range from radar transmitters to jammers and communications systems. This technology is of current interest to the USAF Phillips Laboratory where research efforts have been underway for a number of years. For narrow band phenomena, frequencies in the range of 700 MHz to 3 GHz are of interest. Fast transient waveforms with high power and broad spectral content are also of interest. Risetimes of interest are in the range of 10s of picoseconds to 1 nanosecond, and pulse widths from a few hundred picoseconds to 5 Ns are involved.

Energy may be delivered from a high power wideband source on either a parallel plate or coaxial transmission line. In order to be useful, the energy must be transferred to an antenna to be radiated. This generally requires a mode converter, especially in the case of coaxial sources. Extraction of energy from a coaxial source can be particularly tricky, especially at high voltages and short pulse times. The ability to extract and radiate high voltage energy with very short rise times of 10's to 100's of picoseconds is an area of technology which is only just beginning to be explored. Innovative ideas for the generation, extraction, mode conversion, radiation and focusing of these wideband and ultrawide band signals are solicited.

PHASE I: Select promising techniques for utilizing high power electromagnetic technology. Basic feasibility of the proposed techniques will be investigated to determine the specific approaches, identify critical development requirements, potential risks, and provide a basis for determining the potential success of a Phase II effort.

PHASE II: Develop and fabricate a prototype system, conduct laboratory, and other tests which will demonstrate a capability with clear commercial potential. Develop commercial partnership interests for a Phase III production and marketing program.

PHASE III DUAL USE APPLICATIONS: The Air Force and other military services have needs for fast, high power, ultrawide band electromagnetic sources for applications in transient radar, mine detection, target discrimination and interference testing of military equipment. The civilian sector has similar requirements for locating buried objects such as pipes or underground cables and to perform inspections on concrete structures such as bridges or building foundations.

REFERENCES:

1. W.L. Baker, Air Force High-Power Microwave Technology Program, Aircraft Survivability, published by the Joint Technical Coordinating Group/Aircraft Survivability, Arlington VA, Fall 1995.
2. L.B. Felsen, ed., Ultra-Wideband, Short-Pulse Electromagnetics, Plenum Press, New York, 1993.
3. L.B. Felsen, ed., Ultra-Wideband, Short-Pulse Electromagnetics 2, Plenum Press, New York, 1995.
4. D.V. Giri and C.D. Taylor, High Power Microwave Systems and Effects, Taylor & Francis, Washington DC, 1994.
5. J. Benford and J. Swegle, High Power Microwaves, Artech House, Boston, 1992.

AF98-102 TITLE: High Power Solid State Switches

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop new concepts and enhanced capabilities in very high power, triggered solid state switches for ultrawide band (UWB) transient microwave sources.

DESCRIPTION: High power, high voltage solid state switches are an integral part of the development of pulsed power technology for ultrawide band electromagnetic sources. The development of techniques for accurately triggering fast (50pS to 500pS), high voltage solid state switches (1kV to 150kV) is of interest to the Air Force for a variety of potential applications that range from radar transmitters to jammers and communications systems. This technology is of current interest to the USAF Phillips Laboratory where research efforts are currently underway.

The ability to accurately trigger very fast UWB sources will enhance their capability for use in transient radar, target detection, and target identification. Risetimes of 50 pS to 1nS are commonly produced with current UWB technology. For satisfactory synchronization of arrayed sources, triggering jitter of 10% of the risetime is desired.

PHASE I: Basic feasibility of the proposed techniques will be investigated to determine the specific approaches, identify critical development requirements, potential risks, and provide a basis for determining the potential success of a Phase II

effort.

PHASE II: Develop and fabricate a prototype system, conduct laboratory, and other tests which will demonstrate a capability with clear commercial potential. Develop commercial partnership interests for a Phase III production and marketing program.

PHASE III DUAL USE APPLICATIONS: The Air Force has application for high power solid state switches in high power transient radars for mine detection, location and discrimination of unexploded ordnance, and for wideband jammers. The civilian sector has similar requirements for triggering UWB energy. Potential commercial applications include communications, accurate measurement of distance, and locating buried objects.

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1. W.L. Baker, Air Force High-Power Microwave Technology Program, Aircraft Survivability, published by the Joint Technical Coordinating Group/Aircraft Survivability, Arlington VA, Fall 1995.
2. A. Rosen and F. Zutavern, eds., High Power Optically Activated Solid-State Switches, Artech House, Boston, 1993.

AF98-103 TITLE: Neutralization of Airborne Chemicals

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Development and commercialization of technology to cause neutralization of airborne chemicals to control and reduce contamination/hazards.

DESCRIPTION: Improved methods of capturing and neutralizing airborne chemicals are needed for both military and civilian applications. Rapid and effective control of airborne chemicals before they are dispersed is critical to limiting personnel hazards and casualties. A system capable of being installed at facilities (military and civilian) involved in the manufacture or handling of hazardous chemicals is needed to prevent accidental or intentional release of airborne chemicals. The civilian population risks to accidental exposure to airborne chemicals from chemical plants and transport of chemical products are increasing with increasing population growth and shifts to urban areas. Potential threats to both military and civilian sectors from terrorist acts are also becoming of concern.

PHASE I: Investigate various approaches during Phase I analysis, and/or experiments to demonstrate the feasibility of utilizing directed energy such as electromagnetic fields, laser radiation, or other technologies to either cause the airborne chemicals to settle to the ground where they can be neutralized and/or neutralize them directly while airborne. The results of the Phase I effort should clearly demonstrate not only the feasibility, but establish a defined approach for a Phase II effort. Commercialization and dual-use applications should be developed and potential partners identified.

PHASE II: Develop and demonstrate a prototype system or systems capable of causing airborne chemicals to settle to the ground or be neutralized while still airborne. Prototype systems shall be developed and demonstrated which demonstrate a capability with a clear commercial potential. Develop commercial partnerships and commitments for a Phase III production and marketing program.

PHASE III DUAL USE APPLICATIONS: Commercial applications should include the protection of chemical manufacturing plants and facilities handling toxic materials. Military applications include fixed facilities involved with storage and handling of chemicals and involved with base clean up activities.

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1. St. Clair, "The Sonic Flocculation as a Fume Settler, Theory & Practice," Bureau of Mines Report 3400, 1938.
2. "Ultrasound, Its Chemical & Biological Effects," VCH Publishers Weinheim, 1988.
3. Gutierrez & Henglein, "Journal of Chemical Physics 94," 1990.
4. C. B. Collins and J. J. Carroll, Laser Physics 5, 209-230 (1995).
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AF98-104 TITLE: Weapons Detection

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop automated object systems for the identification of weapons, ordnance, and critical hardware.

DESCRIPTION: Security and law enforcement personnel systems that can automatically identify weapons carried by personnel, ordnance, or critical hardware used by terrorists or criminal elements before they can utilized. Automated methods of performing these functions are desirable not only from the need to keep labor costs down, provide remote unattended monitoring capability, but the need to avoid issues associated with violating the privacy and rights of individuals. Developments in the area of metal object identification based on electromagnetic methods have already been proven successful in walk through metal detectors. Extensions of these methods can be applied to the non-obtrusive surveillance of building entrances, hallways, and other areas to detect weapons and bombs. Both electromagnetic and laser based technologies have the potential to be utilized in passive license plates for vehicle identification. Utilizing multiple sensing of lasers and electromagnetic environments combined with data fusion can enhance weapons detection and identification over single environment sensors.

PHASE I: Develop preliminary concepts and competing approaches utilizing both laser and electromagnetic technologies. Demonstrate feasibility of key elements of the approach or design which will reduce the risks associated with a Phase II effort.

PHASE II: Develop and demonstrate a prototype system that will provide a dual use capability for both military and civilian sectors for counter terrorist or law enforcement needs. The system should be developed sufficiently to allow transition to a Phase III commercial effort to be funded by industry.

PHASE III DUAL USE APPLICATIONS: There is an expanding need for automated object identification systems for weapons in both military and civilian sectors in the United States to protect our personnel and infrastructure against terrorist and criminal threats. Automated sensing systems with remote capabilities are needed to support military security and civilian law enforcement personnel. This capability can also be adapted to support control of theft of high value components such as semiconductor chips and other electronic parts. Other threats posed by terrorists in the civilian sector and by military forces on the battlefield will require a mobile capability.

REFERENCES:

1. C.E. Baum, E.J. Rothwell, K.M. Chen, and D.P. Nyquist, The Singularity Expansion Method and Its Application to Target Identification, Proceedings of the IEEE, vol. 79, No. 10, Oct 1991.
2. C.E. Baum, Concepts in Transient, Broad-Band Electromagnetic Target Identification, Ultra-Wideband, Short-Pulse Electromagnetics 2, Plenum Press, New York, 1994 (to be published).
3. C.E. Baum, Signature-Based Target Identification and Pattern Recognition, IEEE Antennas and Propagation Magazine, Vol. 36, No. 3, June 1994.
4. Gary D. Sower, Detection and Identification of Buried Metallic Targets from Natural Resonances Observed in Scattered Electromagnetic and Magnetic Fields, Progress in EM Research Symposium (PIERS), Seattle WA, July 1995 (submitted).
5. Gary D. Sower (EG&G), Detection and Identification of Mines From Natural Magnetic and Electromagnetic Resonances, Optical Society of America (SPIE), April 1995 (submitted).

AF98-105 TITLE: Hidden Object Identification

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop and commercialize technology for locating and identifying hidden objects.

DESCRIPTION: The wide range of frequencies found in ultrawide band (UWB) radio frequency signals makes it possible to penetrate a wide variety of materials such as foliage, earth, concrete, and wooden structures. Advancements in UWB technology in recent years now make possible the transmission and reception of signals ranging from low frequency magnetic fields to extremely short transients lasting no more than a few hundred picoseconds. Short transients make it possible to resolve objects through clutter such as tree branches or rocks in soil, and low frequency magnetic fields can penetrate almost anything. This, combined with recent advances in electromagnetic scattering theory, high speed computers, and identification algorithms, opens up many new opportunities for development and commercialization of object identification systems.

PHASE I: Investigate various approaches during Phase I, and demonstrate through modeling, analysis, and/or experiment the feasibility of their proposed object detection and identification concept. The results of the Phase I effort should clearly demonstrate not only the feasibility, but establish a defined approach for a Phase II effort. Commercialization and dual-use applications should be developed and potential partners identified.

PHASE II: Develop and demonstrate a prototype system capable of detecting and identifying concealed objects under realistic conditions. Military applications include armed personnel and vehicles hidden by foliage or downed aircraft. Civilian applications include crime scene weapons searches, remote concealed weapons scanning, and hazardous materials containers. Demonstrate a capability with a clear commercial potential. Develop commercial partnership interests for a Phase III production and

marketing program.

PHASE III DUAL USE APPLICATIONS: The civilian sector has similar requirements for detecting crashed aircraft, lost vehicles, and hidden hazardous waste containers. Military requirements for locating hidden tanks, vehicles and other weapons systems in tactical warfare engagements present the same challenges.

REFERENCES:

1. C.E. Baum, E.J. Rothwell, K.M. Chen, and D.P. Nyquist, The Singularity Expansion Method and Its Application to Target Identification, Proceedings of the IEEE, Vol 79, No 10, Oct 1991.
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4. Gary D. Sower, Detection and Identification of Buried Metallic Targets from Natural Resonances Observed in Scattered Electromagnetic and Magnetic Fields, Progress in EM Research Symposium (PIERS), Seattle WA, July 1995.
Gary D. Sower, Detection and Identification of Mines From Natural Magnetic and Electro-magnetic Resonances, Proceedings of the Int'l Society of Optical Engineering (SPIE), April 1995.

AF98-106 TITLE: Space Communications Protocol Standards (SCPS) Integration Into Satellite Operations Infrastructure

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop methods to integrate the SCPS protocol into present/future satellite operations and architecture.

DESCRIPTION: The SCPS program is a joint effort between the DOD, NASA, and the National Security Agency (NSA) in which four upper layer protocols are being developed, tested, and validated. The four protocols include: (1) an application layer protocol to support file transfers called SCPS-File Protocol (FP); (2) a transport layer protocol to support end-to-end data transmission called SCPS-Transport Protocol (SCPS-TP); (3) a network layer protocol to support internet delivery of data called SCPS-Network Protocol (SCPS-NP); and (4) a security protocol called SCPS-SP. Historically, data transmission protocols such as Transport Control Protocol (TCP), Internet Protocol (IP), and File Transfer Protocol (FTP) have been developed with fixed ground applications in mind. Space applications, however, exist in a different operational environment relative to fixed ground applications. For example, most space applications experience constrained bandwidths, higher bit-error rates (BER), dynamic links, higher link delays, and limited computing power onboard the space vehicles. The SCPS protocol suite is being developed to better couple the data transmission protocols to the space environment. It should be noted, however, that the SCPS protocols are also applicable to other non space environments having any or all of the channel characteristics mentioned above. A software coded implementation of the integrated SCPS protocol is being developed, referred to as the "Reference Implementation." The first version of the "Reference Implementation" will be available in February 1997. Additionally, standardization of the SCPS protocol suite is progressing by two routes: (1) Four MIL STDs have been developed and are currently undergoing a technical review with a final version scheduled for September 1997; and (2) Consultative Committee on Space Data Systems (CCSDS) Red Books have been developed that are also in the review process with an expected completion date of late FY97. The final goal is to develop international ISO standards for each of the four SCPS protocols.

PHASE I: (1) Develop alternative concepts and implementation designs to integrate the SCPS protocol suite as described in the referenced MIL STDS into: (a} the near-term Air Force Satellite Control Network (AFSCN) operations infrastructure for use in the 0 to 10 year time frame; and (b) future satellite operations architecture alternatives being formulated by the Air Force and the DOD Office of Space Architect for the post 10-year far-term time frame. (2) Identify a recommended approach for both the near- and far-term time frames that address software, hardware, and/or firmware requirements and design implementations.

PHASE II: Develop a documented prototype SCPS implementation capability, including the necessary software, hardware, and/or firmware required, that can he integrated and tested in an operational environment within the AFSCN.

PHASE III DUAL USE APPLICATIONS: Existing data transmission protocols are primarily for ground-based applications. The SCPS protocol suite is being developed as a solution to this problem and will be applicable to DOD, NASA, and commercial space applications. An especially fertile area for commercial potential will be the evolving personal communications satellite system such as IRIDIUM, Globalstar, Odyssey, and Teledesic.

REFERENCES:

Draft MIL STD 2045 43000, Network Protocol for High Stress, Resource Constrained Environments
Draft HIL STD 2045 43001, Network Security Protocol for Resource Constrained Environments
Draft MIL STD 2045 44000, Transport Protocol for High Stress Resource Constrained Environments
Draft MIL STD 2045 47000, File and Record Transport for Resource Constrained Environments
Consultative Committee on Space Data Systems "Red Books"
Integrated SCPS Protocol, Reference Implementation (SW)

AF98-107 TITLE: Affordable Array Antenna for Multiple Satellite Links

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop cost-effective array antenna concepts for multiple satellite-to-ground and cross links.

DESCRIPTION: Part of the solution to meet the needs for reduction of operating cost and higher efficient satellite network operations, is to use antennas capable of multiple simultaneous links between satellite to ground or another satellite. However, the current phased array antennas employing digital beam-forming networks and phase shift circuits to provide such capability are very expensive. Recently, several low-cost techniques with good performance characteristics such as plasma mirror, row/column steering, liquid crystal/ferroelectric phase shifters, slotted waveguide array, differential rotation of microstrip patch antenna elements, and a number of hybrid techniques to steer RF or laser beams either electronically or mechanically have been developed. These new technologies offer opportunities of investigating the possibility of developing affordable array antennas for cost-effective satellite network operations. The objective of this research is to develop a low-cost array antenna concept for multiple satellite-to-ground and satellite-to-satellite communication links, and assess its feasibility and practicability. The design goals are low cost, long range, flexible frequency change, multiple beams over wide bands, and simultaneous operations with several satellites. Satellite network operations requirements for wide coverage, multiple frequency bands, and high transmission capacity are also to be considered.

PHASE I: Phase I activity shall include: (1) identification of the antenna requirements for supporting satellite network operations in the 2007 and 2015 time frame; (2) evaluation of the applicability of alternative beam forming and steering techniques to develop at least three candidate low cost array antenna concepts; (3) assessment of each candidate concept in terms of technical feasibility, application utility, operational flexibility, and economical viability; (4) identification of new technical issues relating to the practicality of specific candidate concepts, and documentation of detailed conceptual designs and assessment results.

PHASE II: The Phase II activity shall include: (1) the conduct of tradeoff evaluations of the candidate conceptual designs, including but not limited to, different geometric configurations, passive or active transmitter, element types, beam generation, polarization, methods of steering the beam, etc. to synthesize a single optimal conceptual design; (2) construction of computer simulation and/or bread board demonstration selected antenna characteristics to support design analysis, identify key design parameters, and verify the projected capability; (3) through the utilization of an architectural simulation representing AF Satellite Control Network (AFSCN) to develop a concept of operation employing the designed array antenna for AFSCN, and evaluate the antenna's impact on the overall AFSCN performance; (4) rough estimation of life cycle cost of the selected antenna concept within the context of AFSCN; and (5) documentation of all technical results and lessons learned form the Phase II activities and additional technology needs.

PHASE III DUAL USE APPLICATIONS: The antenna concept developed in this research will have both commercial and military application in providing multi-frequency links, multi-beam operations, high data rate and narrowbeam transmission to meet their operational requirements. Low-cost array antenna is capable of improving commercial satellite network performance and reducing operational cost, especially for the ones with large constellation such as IRIDIUM and Telsdesic.

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Dorschner, T. A., Friedman, L. J., Holz, D. P., Rester, R. C., Sharps R. C. and Smith, I. W., "An Optical Phased Array for Lasers," 1966 IEEE International Symposium on Phased Array Systems and Technology, pp. 5 10, October 1996

Hemmi, C. R., Dover, T., Vespa, A. and Fenton, M., "Advanced Shared Aperture Program (ASAP) Array Design," 1966 IEEE International Symposium on Phased Array Systems and Technology, pp. 278 282, October 1996

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Manasson, V., Sadovnik, L. and Mine, R., "MMW Scanning Antenna," IEEE Aerospace and Electronic Systems, Vol. 11, No. 10, pp. 29 33, October 1996

Mathew, J., "Electronically Steerable Plasma Mirror Based Radar Concept and Characteristics," IEEE Aerospace and Electronic Systems, Vol. 11, No. 10, pp. 38 44, October 1996

AF98-108 TITLE: Military Space Ground Link Interface Unit

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop a modular Space Ground Link Interface Unit for Wide Area Networks (WANs).

DESCRIPTION: The current Department of Defense development of the Space Communications Protocol Standards (SCPS) will standardize the protocol suite used in future satellite communications system and change the payload delivery mechanism to Internet Protocol (IP) packets. The older satellites payload transmissions using wavy trains, will still have to be supported. Current satellite developments use Asynchronous Transfer Mode (ATM) cells to transport payloads. A need exists for a modular Space-Ground Link Interface Unit which will accept any type of payload delivery mechanism (wave trains, IP packets, ATM cells, etc.) using "plug and use" network interface cards to reconstitute the payload data into the protocol suite used for a destination WAN. The modular Space-Ground Link Interface Unit will have the routing tables necessary to set the WAN destination address and the network switching capability to interface with the military WANs. All current WAN standards will be supported by the modular Space-Ground Link Interface Unit including ATM and Synchronous Optical Network (SONET). The modular Space-Ground Link Interface Unit will incorporate any encryption device or mechanism used in the delivery of the payload on the WAN. The resulting modular Space-Ground Link Interface Unit will allow a common interface device for all military WANs providing interoperability across the military WANs and eliminating existing, less efficient WAN interfaces. The Space-Ground Link Interface Unit shall be modular in design to accommodate a plug and use methodology and any future technologies or protocol suites. Performance issues shall be considered in the development of the modular Space-Ground Link Interface Unit to minimize the performance impacts on the WANS.

PHASE I: 1)Research and identify (with Government assistance) current and proposed payload transport mechanisms and encryption requirements across the military WANs that will be incorporated into the Space-Ground Link Interface Unit. The design of the Space-Ground Link Interface Unit shall have modular components that will allow the unit to be configured for all the identified transport mechanisms and military WANs. 2) Identify the performance issues that will help minimize the Space-Ground Link Interface Unit impact on the military WANS. 3) Produce a preliminary design for the modular Space-Ground Link Interface Unit. 4) Provide a proof of concept demonstration of the modular design concepts.

PHASE II: 1)Finalize development of the Space-Ground Link Interface Unit that meets and exceeds current and evolving military requirements. 2) Perform system measurement and analysis to determine performance specifications and to verify that all performance issues have been addressed. 3) Provide operational demonstrations which meet jointly {Government and contractor) agreed upon specifications.

PHASE III DUAL USE APPLICATIONS: Application of the modular plug and use Space-Ground Link Interface unit to commercial satellite payload transport mechanisms (in concert with resulting cost savings) would be highly beneficial.

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AF98-109 TITLE: Jammer and Spoofer Detection, Direction Finding, and Location Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop technology, hardware, and software to quickly detect and locate the coordinates of GPS signal interference.

DESCRIPTION: GPS is rapidly becoming a critical component of many civilian as well as military systems. The GPS signals, as received at the Earth, tend to be very weak. This makes them very easy to jam or spoof. RF signals in the GPS frequency band can be openly broadcast and can be used to jam or interfere with the reception of the satellite signals; thus either denying, deceiving, or severely degrading GPS operation. RF transmitters that operate on other frequency bands may produce harmonics of sufficient strength to interfere with local GPS operation. Various mitigation techniques exist, such as adaptive antenna and electronics that null strong jamming signals, adaptive filters that remove narrow band strong signals, and Receiver Autonomous Integrity Monitoring (RAIM) algorithms that detect, isolate, and disregard a false signal (such as a spoofing signal) when computing the GPS solution. However, not all GPS user sets (including civilian uses) will be equipped with sufficient jammer nulling or filtering capabilities, and there is always the risk that a false signal can spoof user sets (even those equipped with RAIM). Thus, instruments need to be developed to detect and precisely locate the coordinates of false signals that interfere with GPS. Once the interfering source has been

identified, action can be taken to control it. Weak signals with power of similar magnitude to GPS signals are not able to jam the receiver, but may spoof the receiver. Stronger signals will jam the receiver, but are easier to locate. A single device would generally only be able to determine the direction, but not the range of a hidden interferer. Thus, triangulation techniques may need to be developed that integrate two or more non co-located devices. The problem is very complex for the case of several dispersed jammers or spoofers, each emitting more than one Pseudo Random Noise (PRN) signal. Most of the basic hardware components needed to develop signal location devices are already available; such as fast correlator chips, IMU's adaptive antenna and electronics, and precise clocks. The hardware components need to be integrated into dedicated electronic devices and the necessary signal processing software and techniques need to be developed to address the signal location problem.

PHASE I: Phase I activity shall be concerned with: 1) innovative integration of the required existing hardware components/assembly, such as (but not limited to) a multi-beam antenna, a many parallel correlator ASIC, an IMU, a precise frequency standard; 2) development of the software to quickly detect and find the direction/location of a GPS signal interferer; and 3) prototype demonstrations for a) the case or the "strong signal" single jammer and b) the case of the "weak signal" spoofer.

PHASE II: Phase II activity shall be concerned with: 1) development of equipment, techniques, and software to detect and find the direction and location of a) multiple non co-located jammer signals, b) multiple Clean/Acquisition (C/A) code co-located spoofer signals, and c) multiple non co-located C/A code spoofer signals; 2) demonstration of the equipment, techniques, and software for determining the coordinates of (the above) multiple jammers and spoofers.

PHASE III DUAL USE APPLICATIONS: Equipment successfully developed as a result of this contract will be used by relevant government agencies to detect and locate the source of a potential GPS signal interferer that disrupts DOD/NASA/commercial GPS operation. Similar techniques can be used to develop equipment for law enforcement involving the offense of the broadcast of signals on reserved frequencies.

REFERENCES:

R. D. Schmidt, "Multiple Emitter Location and Signal Parameter Estimation," IEEE Transactions on Antennas and Propagation, Vol AP-34, No. 3, March 1986

G. F. Hatke, K. W. Forsythe, "A Class of Polynomial Rooting Algorithms for Joint Azimuth/Elevation Laboratory," Air Force Contract F19628-90-C-0002

AF98-111 TITLE: Data Link Control Protocol

CATEGORY: BASIC RESEARCH; Command, Control, and Communications (C3)

OBJECTIVE: Develop a data link control protocol for satellite systems.

DESCRIPTION: Military data networks supporting communications between computers are expanding. Local area networks (LANs) are being interconnected to form wide area networks (WANs) using satellite systems. The standard networking protocols in use by the commercial off-the-shelf computers and networking equipment do not tolerate the bit error rates (BERs) and delays that are typical of satellite links. This results in the inefficient use of satellite resources. The challenge for the innovator is to develop a data link control protocol that will work with the current Transfer Control Protocol/Internet Protocol (TCP/IP) networking protocols or future Asynchronous Transfer Mode (ATM) protocols and allow these protocols to operate efficiently over satellite links.

PHASE I: Design a data link control protocol and identify the protocol's interaction with military standard (TCP/IP) networking protocols. The contractor shall also perform analyses/simulation comparing satellite resource use when the data link control protocol is in use and when only standard networking protocols are in use.

PHASE II: Write software that operates on a personal computer that intercepts IP packets on a LAN interface and routes IP packets not addressed locally to a serial interface port. The software shall be capable of encapsulating the IP packet into the data link control protocol or the standard point-to-point protocol before sending the IP from the serial data port. In addition, the contractor shall perform system tests/simulations (with Air Force assistance) over at least two military satellite systems, Milstar and one transponded system such as DSCS. The tests/simulations shall confirm the efficiency increases documented by the analyses conducted in Phase I.

PHASE III DUAL USE APPLICATIONS: Commercial satellite communications providers are entering the computing market and are also struggling with the problem of efficient use of satellite resources for network connectivity using standard networking protocols. The development of a new efficient data link control protocol would benefit both commercial satellite and networking service providers.

REFERENCES: Krueger, P. E., Rajkowski, J. M., Cloonan, T. F., Plecity, M. S., and Ilse, K., "Experimentation with the Advanced Communications Technology Satellite (ACTS) in Support of the Force Projection Army Doctrine," AIAA Communications Satellite Systems Conference, 1994

AF98-112 TITLE: Low Interference Cross Polarization Phased Array Radiating Elements

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Demonstrate low interference cross polarized phased array antenna operating at wide scan angles.

DESCRIPTION: Phased arrays for mobile platforms operating over commercial Ku-band satellites is of interest to the Government. Frequency reuse environments require good cross-polarization discrimination (XPD) from the terminal antenna in order to minimize interference. Generally, element XPD degrades in phased array antennas as the angle of scan increases from broadside. The dual-linear polarization tracking process could be simplified if XPD were improved. The radiating element is a major contributor to the cross-polarization interference. This challenge exists not only for dual-linear polarization, but also for dual-circular polarization.

PHASE I: Identify candidate dual circular- and dual linear-polarized radiating elements. Wave guide radiating elements and printed circuit elements will be considered as well as other potential high XPD elements. Wide-angle impedance matching surfaces and innovative element feeds will be evaluated for improving crosspolarization discrimination of the radiating elements at large scan angles. Radiating elements will be compared as to cost, performance and complexity and candidates selected for Phase II fabrication.

PHASE II: Fabricate two 16-element phased arrays based on the dual-linear and circular-polarized elements selected from the work in Phase I. A beam steering controller will position the main beam of each phased array. The contractor shall measure the XPD of each phased array to a scan angle of 70 degrees in a laboratory environment.

PHASE III DUAL USE APPLICATIONS: This technology would be useful for any application requiring commercial satellite communications from mobile platforms. It will likely be scalable to other frequency bands.

REFERENCES:
"Antenna Theory Analysis and Design," Balanis, C., Harper and Row
"Antennas," Kraus, J., McGraw Hill
"Antenna Theory and Design," Elliott, R., Prentice Hall

AF98-114 TITLE: Application of Nonlinear Dynamics to Specific Problems in Space Communications

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Apply the methods of nonlinear dynamics to specific problems in space communications.

DESCRIPTION: The emerging science of nonlinear dynamics offers many opportunities to address space communications problems in novel ways. Two such examples are: 1) The ability to synchronize identical chaotic systems suggests a new approach to the implementation of secure communication channels. The fact that two chaotic attractors must be nearly identical in order for synchronization to take place suggests that immunity to unauthorized interception is possible with these methods. 2) It has been shown that controlled chaos can be used for digital signaling. With this method, the state space in which the chaotic attractor resides is partitioned into subspaces, each of which represents a given symbol. The transmitting system is then comprised of a chaotic oscillator in which the trajectory can be directed from one space to another under the direction of the input modulating signal.

PHASE I: Investigate the key issues and perform tradeoffs to determine the applicability of the use of non-linear dynamics to secure digitally processed satellite communication channels. Provide basic feasibility demonstration of applying non-linear dynamic technology to digital transmission/reception.

PHASE II: Design/construct a prototype system and perform sufficient tests/evaluations to prove the feasibility of such a system. Among other issues, the prototype system shall demonstrate capability to handle density and non-volatility requirements, time delays, and robustness of military satellite communication.

PHASE III DUAL USE APPLICATIONS: The systems developed under this project will be useful for numerous civilian programs. Both law enforcement and the commercial banking industry are likely users of this technology.

REFERENCES:
Silva, C. P., "The Application of Chaos to Communications," 1995 IEEE MTT S International Microwave Symposium, Orlando FL, May 1995
Hayes, S., "Using Controlled Chaos For Digital Signaling," 1995 IEEE MIT S International Microwave Symposium, Orlando FL, May 1995

AF98-115 TITLE: On-the-Fly, Lossless Data Compression

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop a lossless data compression system for use with satellite systems

DESCRIPTION: The military is expanding its use of computers and the data networks supporting communications between the computers are also expanding. Local Area Networks (LANs) are being interconnected to form Wide Area Networks (WANs) using satellite systems. The data rates on these WAN links are generally far less than required to support the timely transfer of perishable data. The data subsystem does not have sufficient time to format and file the perishable data for compression processing. Two alternatives for increasing transfer rates are: 1) increased use of satellite resources, and 2) on-the-fly data compression within the data network. The challenge for the innovator is to develop an inexpensive, lossless hardware or hardware/software compression system that will not adversely affect either the current Transfer Control Protocol/Internet Protocol (TCP/IP) networking protocols or future Asynchronous Transfer Mode (ATM) protocols.

PHASE I: Produce/demonstrate a conceptual design of one or more compression systems and identify the system's effects on networking protocols. The contractor shall also identify interface requirements between satellite systems and cryptographic equipment.

PHASE II: Develop a working prototype of the system as a proof-of-concept device. In addition, the contractor shall perform system tests (with Air Force assistance) over at least two military satellite systems, Milstar and one transponded system such as DSCS. The tests shall demonstrate that the compression system increases information throughput over satellite links without adversely affecting standard networking protocols.

PHASE III DUAL USE APPLICATIONS: Commercial satellite communications providers are entering the computing market and are investigating the problem of lossless data compression for network connectivity. A lossless data compression system would be very useful in circuit switched networks where bandwidth limitations also exist.

REFERENCES:
"Universal Source Coding for Data Compression," Draft Recommendation for Space System Data Standards, CCSDS 121.0 R1 Red Book, Washington D.C.; CCSDS, Nov. 1995
"Telemetry Channel Coding, Recommendation for Space Data Systems Standards," CCSDS 101.0 B 3 Blue Book, Issue 3, Washington D. C.; CCSDS, May 1992
"The Data Compression Book," Nelson, Mark, and Gailly, J. L., 2nd. Ed., M&T Books, New York, 1996
"Computer Networks," Tannenbaum, Andrew, Prentice Hall, Englewood Cliffs, N.J., 1983

AF98-116 TITLE: Security and Robustness Enhancement Techniques for Commercial Satellite Communication Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop and assess performance of security and robustness enhancement techniques for emerging commercial satellite communications systems.

DESCRIPTION: The U. S. Government is seriously considering the use of commercial assets to help meet its rapidly growing military satellite communication systems requirements. In particular, the Government hopes to take advantage of the expected explosive growth in Mobile Satellite Services (MSS) during the next decade. These systems may be able to provide services critical to the future warfighter. However, military communication systems generally require a level of security and robustness that are not considered in a commercial system. Specifically, military systems generally require protection against signal interception and exploitation, jamming and deception, and user geolocation. Hence military systems employ such techniques as authentication and encryption, spread spectrum waveforms, and interference rejecting antennas and filters. Systems such as Milstar are extremely secure and robust. In similar fashion, commercial systems must deal with unintentional or self jamming and must provide mitigation against

other link degrading phenomena such as multipath fading. As a result, these systems also have some degree of inherent robustness. For example, code division multiple access (CDMA), which will be used by several systems, provides some degree of interference protection. User authentication, necessary to keep non-subscribers from using the system, provides some protection against exploitation and large numbers of satellites (in the constellations being proposed) may even make effective jamming a non-trivial and expensive task. Thus, a relatively modest retrofit may be sufficient to bring the security and robustness of some MSS up to an acceptable level.

PHASE I: Assess the vulnerability of selected MSS systems to interception, exploitation, jamming, and geolocation threats. Perform the necessary analyses and/or simulations. Identify/demonstrate techniques to enhance security and robustness of these systems.

PHASE II: Evaluate/finalize selected techniques to enhance the security and robustness of these (MSS) systems. Focus in particular on retrofit concepts and those that are cost effective. Perform design, breadboard test, computer simulation, or whatever analysis is necessary to demonstrate the viability and performance of the selected techniques.

PHASE III DUAL USE APPLICATIONS: The techniques developed under this project will benefit communications technology in both the commercial and military worlds.

REFERENCES: Russell, D. Gangemi, G. "Computer Security Basics," O'Reilly and Associates, Inc. 1992

AF98-117 TITLE: <u>Simulation Toolkits for Switching Satellite Communications Systems</u>

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Develop a simulation toolkit for packet/circuit switched satellite communications systems.

DESCRIPTION: It is expected that there will be many new simulations for future satellite systems for at least three reasons: (1) There are expected to be major architectural differences from previous satellite communication systems. For instance, using full processing (packet switching and/or circuit switching) instead of partial or no processing. (2) Closer integration and interoperation of military satellite communications systems with commercial communications systems and terrestrial defense communications systems. (3) Prior simulations are generally built from the ground up using programming languages instead of commercial simulation tools. This means they are relatively difficult to modify, compared with those built on top of commercial simulation tools. During the development of future satellite communications systems there will be several traffic analysis simulations needed. For instance, protocol development, failure vulnerability analysis, operations analysis, and user traffic impact studies. Any work to prepare general methods and simulation constructs (code that can be used by multiple simulations) could improve the quality and decrease the time/cost associated with these simulations. Simulation toolkits are required which contain some methodology that leads to the verification of the simulation results. A need exists to define future expected traffic analysis simulations and develop 'toolkits' applicable to many satellite communications simulations. These toolkits should consist of methods and simulation constructs built on top of a commercial simulation modeling tool such as Ontario Provincial Network (OPNET). The toolkits should contain documentation that show how to use these toolkits and that show future simulators how to achieve a simulation end (for instance, protocol development or failure vulnerability analysis). The toolkits should take into account the need for satellite communication systems to interface with the overall Defense Information System Network. Integration with commercial communications systems and use of commercial protocols should also be taken into account.

PHASE I: 1) In cooperation with the government, identify/develop useful toolkits (add-on software modules for a commercial network simulation product such as OPNET) in areas of interest in development of packet/circuit switched communications satellites such as satellite protocol development or failure vulnerability analysis, and create a preliminary user manual for them. 2) Develop a simulation function diagram, theory and methodology. 3) Demonstrate a prototype of key functions.

PHASE II: 1) Using an industry standard tool (such as the OPNET communications network simulation software), create a traffic analysis toolkit for packet/circuit switched satellite communications systems. A toolkit is one or more additions to a tool that customize it for a specific application (in this case, satellite communications simulations). 2) Complete the simulation toolkits development. 3) Demonstrate the simulation with verification. 4) Complete documentation and create the simulation toolkits with user manuals.

PHASE III DUAL USE APPLICATIONS: The commercial space industry can use this simulation toolkit to improve their ability to perform traffic analysis. This capability enables industry to architect more cost effective systems that meet their customers' requirements while simultaneously reducing the time required to architect the system.

REFERENCES: Computer Networks, 3rd Ed: Hon. Tannenbaum, A., Prentice Hall 1996

AF98-118 TITLE: WWW Management Tools for Satellite Communications Management

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop management tools for existing management tools that can be used for satellite communications management.

DESCRIPTION: Satellite communications management requires global collaboration among military command and federal agency planners, analysts, engineers, and others to ensure the most effective and timely allocation of communications resources to the various users. Current tools such as the MILSATCOM Automated Communications Management System (ACMS) focus on the planing, controlling, and monitoring functions needed for communications management, but do not provide sufficient support for the large amount of coordination required. Current communications management tools are military unique and insufficiently aligned with commercial practices. A need exists to apply the concepts of World Wide Web (WWW) technology to the development of a satellite communications management/coordination/simulation tool. Application of WWW technology, for satellite communications/coordination management would involve use of the Common Gateway Interface, Java languages multimedia viewers, associated services such as electronic mail, and development/application of WWW methodology and tools. The resulting WWW satellite communication management/coordination/ simulation tools should initially include 20 Geo Synchronous Earth Orbit (GEO), 10 Medium Earth Orbit (MEO), and 10 Low Earth Orbit (LEO) communication satellite systems, together with the capability of expansion to include all of the commercial satellites system which are owned and/or partially owned, by U.S. companies or allied.

PHASE I: 1) Create an architecture for the application of World Wide Web (WWW) technology to satellite communications management. 2) Integrate (among others) current WWW tools (i.e. Common Gateway Interface, Java language, multimedia viewers, and associated services such as electronic mail) into the communications management architecture. 3) In cooperation with the government, create a preliminary set of WWW based coordination management/ simulation tools and preliminary user manuals.

PHASE II: 1) Finalize the WWW based coordination management/simulation tools program for use with current and future Government satellite communications management systems. 2) Create recommendations on how to evolve the satellite communications management tools towards integration with commercial tools. 3) In cooperation with the Government, apply the communication management tools to a selected satellite system and demonstrate/evaluate the resulting simulation.

PHASE III DUAL USE APPLICATIONS: The WWW management tool can be available to all users of satellite communications systems that need to globally manage their satellite communications resources. The tool also can be beneficial to small commercial companies who provide communication services (such as phone, fax, data, paging, etc.).

REFERENCES:

"Myths About Congestion Management in High Speed Networks," Internetworking Research and Experience, Jain R., 1992
"Resource Sharing Computer Communications Networks," Proceedings of the IEEE, Nov. 1972, pp. 1397-1407

AF98-119 TITLE: Digital Beamforming Development

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop architecture(s), appropriate algorithms, and implementation concepts for a satellite payload that utilizes digital beamforming on receive and/or transmit.

DESCRIPTION: Phased array or multiple beam antennas use beam forming networks to (1) form a desired radiation pattern, and/or (2) generate multiple beams from the same aperture. If a large number of beams or maximum flexibility is required, an all-digital implementation of this beam forming network is worthy of consideration. This requires, however, that the received signals from an array of antenna elements are individually pre-amplified, frequency down-converted, digitized, and then fed into a digital processor, where beam forming and other functions, such as channelizing (demultiplexing and filtering), are performed. Similarly, on transmit, the array must digitally combine multiple beam signals, D/A convert, frequency up-convert and linearly amplify each channel. Multiple agile beams (perhaps in the hundreds) could be simultaneously formed in the digital processor. Each beam could be specially contoured and directed to satisfy a specific regional coverage requirement. Sidelobes could be lowered to permit frequency reuse operation, or even to mitigate RF interference from non users. Each of these capabilities could be implemented with either fixed algorithms, or algorithms having adaptive features. The digital processor architecture should also permit channel and beam assignments to be made with full flexibility. The key performance issues are the availability of enough dynamic range and bandwidth in the A/D converters and the capacity and speed of the digital processor. The viability of digital versus analog beamforming depends not only on performance, but ultimately on the relative impacts on payload size, weight, and especially power. A beam-forming test

bed should also be developed along with the digital processor prototype. Proposals that address innovative A/D Converter and high speed Digital Signal Processor designs will also be considered.

PHASE I: Investigate candidate digital beamforming/channelizing architectures, and develop top level functional descriptions of the selected architecture(s). Assess the status of component technology, particularly A/D Converter and Digital Signal Processors technology, and develop a prototype design and performance specifications(s) for a proposed digital processor. Provide proof of concept documentation and/or simulation of the proposed design(s).

PHASE II: Develop the appropriate beamforming and other algorithms for the selected architecture(s). Perform tradeoffs and analyses to evaluate and develop an implementation approach to the architecture(s) selected in Phase I. Develop a computer model of the proposed digital processor to assess and demonstrate performance. Develop a prototype processor and demonstrate key performance characteristics through an appropriate test bed.

PHASE III DUAL USE APPLICATIONS: Both military and commercial systems would benefit from the flexibility of digital beamforming/channelization, even though the emphasis and resultant architectures would likely be different. Commercial systems are usually interested in deploying a large number of beams and in frequency reuse. Future military systems, on the other hand, must consider robustness and consequently high dynamic range as a critical requirement, but will also employ frequency reuse to meet growing requirements for high capacity.

REFERENCES:

Application of Digital Beamforming Antenna Technology to Microwave Remote-Sensing and Communication Satellites, Wood, P. J. (CAL Corp., Ottawa, Canada), Sultan, N. (Canadian Space Agency, St. Hubert, Canada); IAF, International Astronautical Congress, 46th, Oslo, Norway, Oct. 2-6, 1995, p.7; IAF Paper 95-B306; AIAA Technical Library (IAA9601)

A Current Evaluation of the Digital Beamforming Testbed at Rome Laboratory Technical Report, Jul 1992 - Jul 1993, Humbert, W. R., Steyskal, H., Rome Laboratory, Griffiss AFB, N.Y., 1993, 42 pages; AIAA Technical Library

Tradeoff Study of Onboard Digital Signal Processing for Satellite-Based Personal Communications, Feldman, N. E., Han, J., Ksienski, D. A., Son How, K. M., Tam, T. T., and Woo, K. T., (The Aerospace Corporation, El Segundo, CA); 45th Congress of the International Astronautical Federation, October 9-14, 1994, Jerusalem, Israel; (IAF-94-M.2.282)

Corden, I. R., and Carrasco, R. A., "Fast Transform Based Complex Transmultiplexer Algorithm for Multiband Quadrature Digital Modulation Schemes," IEEE Proceedings, Vol. 137, pt. 1, No. 6, pp. 408-416, December 1990

Bi, Guoan and Coakley, F. P., "The Design of Transmultiplexers for On Board Processing Satellites Using Bit Serial Processing Technique," AIAA Conference, pp. 613-622, 1990

AF98-120 TITLE: Digitally Adaptive Nulling Algorithm Development

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop adaptive nulling algorithms for an all digital adaptive nulling processor.

DESCRIPTION: Adaptive nulling can be used on a communication satellite system to protect against uplink jamming. This technique involves modifying the receive antenna pattern such that a pattern null is placed in the direction of the jammer. Furthermore, it must be adaptive because the location of the jammer and its operational strategy would not be known a priori. Current nulling systems, such as in Milstar II, employ basically a single fixed algorithm, implemented in a hybrid analog/digital processor. Considerably more flexibility could be achieved with an all-digital processor. Multiple algorithms could be implemented specifically to make the nuller more immune to intelligent jamming. Algorithms with additional constraints to achieve, for example, better pattern coverage for users might also be implementable in an all-digital processor. New algorithms could even be uploaded to enhance nulling performance during the operational lifetime of the satellite. Many of these algorithms have already been studied in the literature. The key issues are how to implement an overall architecture and the amount of processing capacity and speed that can be made available under reasonable constraints on weight and power.

PHASE I: Investigate and/or develop adaptive nulling algorithms for on board, all-digital processing application. Develop an overall architecture for a multiple-algorithm, all-digital processor. Develop simulation tools and demonstrate key performance.

PHASE II: Assess the status of digital processing component technology, and determine the feasibility of implementing the digital architecture developed in Phase I. Generate estimates of hardware size, weight, and power. Perform analysis and simulation to assess nulling performance, particularly to evaluate the response time against various types of jammers. The contractor should also include performance demonstrations of adaptive nulling that is relevant to the commercial space craft world.

PHASE III DUAL USE APPLICATIONS: Commercial systems encounter RF interference from unintentional sources. These instances are increasing due to the limited communications spectrum being shared by a growing number of communication systems. Through the use of adaptive nulling, commercial systems will have the ability to maintain performance.

REFERENCES:

"Covariance Matrix Estimation Errors and Diagonal Loading in Adaptive Array," Carlson, Blair D., Member, IEEE Lincoln Laboratory (M.I.T.); IEEE Transactions on Aerospace and Electronic Systems, Vol. 24, No. 4, July 1988

"Adaptive Array Beamforming for Cyclostationary Signals," Yu, Shiann-Jeng, and Lee, Ju-Hong, Member, IEEE; IEEE Transactions on Antennas and Propagation, Vol. 44, No. 7, July 1996

"Performance of DMI and Eigenspace Based Beamformers," Chang, Lena and Yeh, Chien-Chung, Member, IEEE; IEEE Transactions on Antennas and Propagation, Vol. 44, No. 7, July 1996

"A Novel Fast Algorithm for Adaptive Digital Beamforming Using Spatial Spectrum Estimate," Zhu, Jianliang Ren, Qunshu (Nanjing Research Institute of Electronic Technology, China); CIE 1991 International Conference on Radar (CICR-91), Beijing, China, Oct., pp. 22-224, 1991, Proceedings (A93-31631 12-32); International Academic Publishers, 1991, AIAA Technical Library-IAA9312

AF98-121 TITLE: EHF/SHF/Ka Communications Link Attenuation and Availability Model

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop a computer model for predicting satellite communications link attenuation and availability at EHF/SHF/Ka frequencies.

DESCRIPTION: Atmospheric propagation effects can significantly impair the performance of satellite communications links operating at the EHF/SHF/Ka frequencies. Existing propagation models, primarily due to shortcomings in the weather and attenuation measurement database do not provide a satisfactory framework for estimating link performance and often give conflicting results. There are also significant shortcomings in the environmental databases that support these models, especially the lack of instantaneous rainfall rate and frequency of occurrence data for more than a small number of selected locations. The recent availability of EHF/SHF/Ka satellite link attenuation data from the NASA ACTS satellite and other sources may now facilitate the development of a comprehensive model of link attenuation/availability that will better address the needs of a worldwide EHF/SHF/Ka satellite communication system.

PHASE I: Structure a link attenuation/availability model and environmental database shall be developed, based on Air Force input together with an analysis of existing models and expanded data sources. Sources of data to be used to calibrate and verify the model shall be identified. Proof of concept documentation and/or simulation shall be provided as a basis for Phase II feasibility. A comprehensive plan for Phase II shall be prepared.

PHASE II: The Phase II effort shall include three tasks: 1) Finalize Link Attenuation/Availability Model Development. The model shall accurately calculate attenuation (dB loss) and availability (percentage of time) for a bi-directional communications link between a ground terminal and a satellite as a function of carrier frequency, elevation angle, and terminal environment (temperature, humidity, rain rate, cloud cover, fog, altitude, etc.). The model must be tailored to meet limitations imposed by the available environmental data. The model should focus on the 44 GHz/21 GHz uplink/downlink Milsatcom frequencies, but should also be applicable to EHF/SHF/Ka frequencies used and proposed by commercial systems. The model development effort should build on the existing body of knowledge and inventory of models by recalibrating to the recently available data. 2) Environmental Database Development: a global database of weather data specifically tailored to the format of the model shall be developed. 3) Computer Program Development: The link attenuation/availability model and the environmental database will be combined into a single user-friendly computer program tailored to the task of analyzing EHF/SHF/Ka link performance. The program will generate color-coded maps depicting link attenuation or availability on a global or regional scale, contours of constant link attenuation or availability, or point estimates for specific locations (with an option for the user to input site specific environmental data). The program will generate availability for a link with a specified margin, or will generate the margin required to achieve a specified availability. The results will be an annual average or season specific. All outputs will reflect the orbital motion of a specified satellite constellation.

PHASE III DUAL USE APPLICATIONS: The model will be inherently applicable to both military and commercial communications systems operating at EHF/SHF/Ka frequencies. Using this model, commercial satellite developers will be able to accurately predict the required power levels of their transponders.

REFERENCES:
Crane, Robert K., "Electromagnetic Wave Propagation through Rain," John Wiley & Sons, New York, 1996
CCIR International Radio Consultative Committee, "Propagation in Non Ionized Media," Reports of the CCIR, 1990, Annex to Volume 5, International Telecommunications Union, Geneva, 199O
Ippolito, Louis J., "Propagation Effects Handbook for Satellite Systems Design," Fourth Edition, National Aeronautics and Space Administration, 1989

AF98-122 TITLE: Mutual Input/Output Photonic Sensors

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop a photonic output for sensor detector elements operating in the ultraviolet/visible/ infrared wavelengths.

DESCRIPTION: Key limiting factors in sensor performance are noise and delay in getting a signal off the detector and into a signal processor. Current practice is to accomplish this with various electronic signal conditioning, analog-to-digital conversion, and amplification steps. Some type of storage, display, or transmission operation would follow to complete the sensing process. All of these steps can be severely affected by electronic noise; particularly in military environments where radiation, interference, and jamming are common. Incorporating photonics technology into sensor system front-ends offers the opportunity to solve many of these problems. By using light to carry information as early as possible from a detector array, the signal becomes almost impervious to electromagnetic interference. Besides the inherent noise reduction possible with this method, it provides the opportunity for efficient optical pre-processing of target data. In cooled infrared sensors it would also slash the thermal loss that comes from carrying an electrical signal from a cryogenic dewar to an ambient environment. This approach would substantially reduce the weight and power requirements for forward looking infrared sensors, and extend the operation of satellite sensors where consumable cryogenics strictly limit system lifetime. Even more significant is the ability of such sensors to directly interface with the coming light-based digital network. Combined with advances in parallel processing and optical correlation, near real time automatic target recognition will become practicable. This would help bring about a tremendous improvement in battlefield surveillance and global intelligence gathering capabilities. Commercial applications would benefit as well from this technology. The low noise and high speed characteristics of purely optical detector outputs would translate into higher system data throughput. This would be a boon to medical diagnostics, law enforcement operations, and environment monitoring. Huge markets for the mutual input/output sensors would be found in intelligent highway vehicle systems and mass communication networks. Dual-use applications are likely anywhere an optical sensor is now used, from industrial process control to mail sorting, to virtual reality entertainment products.

PHASE I: Develop preliminary designs for a digital photonic output, directly from a detector array. Provide a limited demonstration to show feasibility of approach.

PHASE II: Design, build, and demonstrate a photonic output system for (an Air Force designated) advanced sensor(s). Develop plans required for airborne and satellite demonstration.

PHASE III DUAL USE APPLICATIONS: The photonic output sensor technology developed under this contract will have application in a variety of military and civilian terrestrial and aerospace sensor systems.

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AF98-124 TITLE: Generic Intelligent User Interface Agent

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a generic intelligent interface agent architecture and working agent.

DESCRIPTION: Computer systems are becoming increasingly complex, so complex that the average is user is often overwhelmed. The recent research push for interface intelligence attempts to solve the problem by providing complexity abstraction and intelligent

assistance in a self-contained software agent that communicates with the user through the user interface. This agent can learn individual user preferences and tendencies to provide automated assistance, thereby acting as an "intelligent assistant" or a "smart instrument." A complete intelligent interface agent would be collaboratively adaptive to individual users by observing user behavior and collecting behavior metrics such as keystrokes, device utilization, task performance, and application execution. The agent would then store the behavior using a dynamic knowledge representation that recognizes relationships between behaviors and captures uncertainty into a cognitive model of the user. Finally, the agent would act on observed behavior according to user defined levels of assistance through collaborative, multimodal dialogue. Actions can include reorganization of menus and dialogues, streamlining task procedures, performing complex, repetitive tasks, and a myriad of other possible assistance opportunities. Adaptive user interfaces such as GESIA and EDWARD begin to address the usefulness of intelligent interfaces but fail to realize the full scope of possibilities, particularly the importance of developing a generic intelligent interface agent architecture. A generic architecture can serve as a roadmap to widespread adoption into all computer system user interfaces. This quickly emerging technology shows great promise and is a national priority. In fact, the subcommittee tasked by the President for planning United States technology development places emphasis on intelligent interfaces as one of a three part technology base vital for meeting National Challenges.

PHASE I: Investigate the feasibility of developing a generic intelligent interface agent architecture and working agent that can operate as part of the USAF Defense Information Architecture (DII) Common Operating Environment (COE). Provide a preliminary design of such an architecture which is compliant with DII COE requirements and can perform complexity abstraction and intelligent assistance for applications residing in the COE.

PHASE II: Develop the architecture and implement a DII COE compliant generic intelligent interface agent that provides complexity abstraction and intelligent assistance to COE applications.

PHASE III DUAL USE APPLICATIONS: Intelligent interface capabilities can be used in a wide range of military systems, from desktop to cockpit. These capabilities can also be used in all types of commercial application user interfaces, to include business, engineering, and medical.

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AF98-125 TITLE: Object Oriented Design of Legacy Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Develop a method for harvesting and exploiting object oriented data from IDEF models of command and control systems.

DESCRIPTION: As we move into the 21st century, the Air Force faces the daunting task of re-engineering legacy systems to take advantage of advances in Information Technology. The DOD Joint Technical Architecture (JTA), requires an open, standard-based approach offering significant opportunities for reducing cost and cutting development and fielding time through enhancing software portability ease of systems upgrade, and hardware independence. The basis for the JTA is the Defense Information Infrastructure (DII) Common Operating Environment (COE). The COE concept provides for a reusable sense of common software services via standard application program interfaces (API). This concept mandates the use of object-oriented technology in both the analysis and design of current and future systems. Both the Global Command and Control System (GCCS) and the Global Combat Support System (GCSS), which are being built upon the JTA and COE standards, require the migration of legacy command and control systems to these new, unified systems. Successful migration of these legacy systems will require the evolution of those systems to object oriented technology. The advantages of object oriented technology in reusability, efficiency, and development are well-established. What isn't so well established is how one takes advantage of this technology in order to evolve legacy systems or

develop new ones. Part of the re-engineering, or even understanding, of any system is the modeling of that system. Modeling techniques mandated by the JTA include IDEF0 for activity modeling and IDEF1X for data modeling. There can be much object-oriented information implicit in such models. Exploitation of such information would allow object-oriented analysis and design, which, in turn, would lead to the building of a new, evolved object-oriented system. The Air Force, then, is looking for methods of extracting object-oriented information from IDEF models and using it to expedite the object-oriented analysis and design of new systems.

PHASE I: Design and demonstrate the feasibility of a technique for extracting object oriented data from IDEF models; design and demonstrate a technique for using this data for the object-oriented analysis of an existing system and the object-oriented analysis and design of a future system.

PHASE II: Construct and demonstrate a software tool based on the technique developed in Phase I. Demonstrate the effectiveness of this technique.

PHASE III DUAL USE APPLICATIONS: This software will be useful in the evolution of any information technology reliant system, whether for commercial or defense applications. The DOD Joint Technical Architecture (JTA), with its foundation in the DII COE, has a great need for such software in the evolution of legacy command and control systems, the development of new command and control systems, and in ensuring compliance of developing systems with DII COE standards. This software could also be highly useful throughout the spiral development process delineated in the Electronic Systems Center (ESC) Command and Control Acquisition Framework. In the commercial sector, similar trends in systems and software development require a tool for object oriented analysis and design of existing and future products. This software would greatly assist the Object Modeling Technique (OMT) process, from requirements and analysis through design and coding. The prevalence of IDEF modeling in the commercial sector testifies to the need to turn conceptual models into real systems. This software will provide the means for accomplishing this transformation.

REFERENCES:

DOD Joint Technical Architecture: http://www-jta.itsi. disa.mil
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AF98-126 TITLE: Advanced Distributed C4I Simulation Capabilities

CATEGORY: Advanced Development; Modeling and Simulation (M&S)

OBJECTIVE: Develop Modeling and Simulation technology for use in analysis, training, and acquisition based modeling.

DESCRIPTION: Historically, Modeling and Simulation (M&S) programs have been developed to serve particular purposes, with little or no attention to later integration or interoperability. The Air Force has recognized these deficiencies and is now emphasizing the definition of standard architectures, frameworks, representations, etc. The goals are to reduce the number of models and simulations employed, and to maximize re-use, interoperability, and utility. The research proposed under this topic may address different domains of simulation, such as training, analysis, test and evaluation, etc., and varying degrees of resolution, such as entity or aggregate levels. Or, the research may span interoperability questions across varying domains or levels of resolution. Unique and innovative applications of existing commercial tools will be considered. The following is a specific list of interest areas:

a. ADVANCED VIRTUAL BATTLESPACE SYNTHETIC ENVIRONMENT: The use of advanced visual and distributed computing techniques to provide synthetic battlespace feeds to real command and control (C2), such as those which enhance the operation of the ESC Command and Control Unified Battlespace Environment (CUBE).

b. INTER-DOMAIN SIMULATION INTEROPERABILITY: The integration of various M&S capabilities, initially intended for a specific purpose (e.g., training, analysis, etc.) and now interoperating in a high level architecture, into common frameworks for the future.

c. MULTI-LEVEL SIMULATION INTEROPERABILITY: Correlation of models which currently represent various levels (e.g., system, engagement, mission, theater) of war within a given domain of modeling and simulation.

d. ADVANCED EXERCISE SCENARIO GENERATION: Advanced capabilities to generate visual scenarios such as system laydown, geographical representation, weather effects, etc., for use in ESC's Modeling and Simulation Center (MASC).

e. ADVANCED EXERCISE AFTER ACTION REVIEW AND ANALYSIS (AARA): Tools which can be used for AARA, such as statistical analysis, plotting, etc., and used for either training or analysis purposes.

f. COMMAND & CONTROL (C2): Simulation tools, designs, approaches, etc., which enhance C2 processes, operations, stimulation, or embedded capability.

g. SPIRAL DEVELOPMENT: Tools, techniques, strategies, etc., which contribute to the ESC spiral development methodology.

PHASE I: Research and analyze the modeling and simulation state, specifically relative to C2 issues, provide a plan for addressing one or more aspects of the enhancement of C2 modeling, simulation, training, and/or analysis, and demonstrate the feasibility of the proposed approach.

PHASE II: Develop a prototype of the proposed approach and demonstrate its capability to be employed in ESC's Modeling and Simulation Center (MASC) or C2 Unified Battlespace Environment (CUBE) as part of spiral engine toolkit capability.

PHASE III DUAL USE APPLICATIONS: The modeling and simulation area is significantly ripe for both commercialization and dual use applications. Modeling and simulation is currently used extensively in the private sector, for both business and pleasure (games, amusement parks, etc.). The tools, prototypes, and research developed under this topic will be broadly applicable to the commercial sector with application to games, business use, the medical community, etc.

REFERENCES: CUBE: http://www.hanscom.af.mil

AF98-127 TITLE: Innovative C4I Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop innovative technologies for enhancing the performance, availability, and affordability of C4I systems and subsystems.

DESCRIPTION: Proposals may address any aspect of C4I pervasive technologies not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, innovative concepts and technologies in: Global Awareness, Dynamic Planning and Execution, and Global Information Exchange.

1. Global Awareness:
Global Awareness encompasses the requirements for intelligence, surveillance and reconnaissance and provides consistent battlespace knowledge and precision information in a global information base. Global Awareness develops the common picture of the battlespace providing enhanced real-time information to the warfighter which is as complete and on demand as required. It entails the operational capability for all pertinent levels of command to know and understand the relevant global military situation on a common, consistent basis. The functional capabilities necessary to achieve Global Awareness are:

Consistent Battlespace Knowledge -- The capability to elevate the level and speed of the warfighter's cognitive understanding of friendly, enemy, neutral, and geospatial situations, and to maintain consistency in that view across strategic, tactical and support forces.

Precision Information -- The capability to develop and manage sufficient and timely multi-modal operational information to assure an accurate and precise situational awareness to promote Consistent Battlespace Knowledge.

Global Information Base -- The capability to acquire, deconflict, fuse, store, maintain, support, and display worldwide operationally relevant data. Specific features include in-time tasking and zooming, consistency, integrity and authentication.

2. Dynamic Planning and Execution:
Dynamic Planning and Execution is the operational capability to rapidly acquire and exploit superior consistent knowledge of the battlespace in order to shape and control the pace and phasing of engagements. Dynamic planning and execution encompasses a total warfare planning process from readiness and deployment planning to shooter engagement across the full spectrum of foreseeable military operations. All effort is focused on exploiting a superior understanding of the battlespace in order to shape expected actions within the adversary's decision cycle to proactively engage in rapid, tailorable, planning and execution integrated vertically and horizontally across mission, functions, and organizations. The intent is to construct agile robust plans in which near-real time modifications can be triggered by changes in the battlespace while maintaining consistency and minimizing disruption. The functional capabilities necessary to achieve Dynamic Planning and Execution are:

Predictive Planning and Preemption -- The capability to be proactive in the planning process across echelons, missions, components, and coalition forces. These capabilities extend to integrating other than hard kill weapons, mobility, logistics and ISR management into the planning process, as well as planning to anticipate and avoid surprise. The goal is to have a predictive understanding of the battlespace and to exploit it to shape expected actions within the adversary's decision cycle.

Integrated Force Management and Execution -- The ability to rapidly interleave planning and execution in order to achieve just-in-time tasking tied to a central strategy that spans the battlespace. The goal is to gain efficiency and agility in the pursuit of the commander's objectives within a dynamic battlespace.

Execution of Time Critical Missions and Real-Time Sensor to Shooter Operations -- The capability needed to enable target acquisition, battle management analysis, decision, and resource assignment, and in-time engagement. These requirements extend

to a broad spectrum of time critical missions, from time phased attack of fixed and moving targets to the use of hunter-controller-killer assets. Since the C3I decision time cannot exceed the target exposure time, a key capability is C3I time critical operations.

Joint, Combined and Coalition Operations -- The capability and enabling decision making infrastructure needed to achieve dynamic synchronization of large scale missions and resources from components and coalition forces.

3. Global Information Exchange:
Global Information Exchange is the ability to interconnect all members of the Air Force via a netted communication and information system, available everywhere for any task or mission. The ability to communicate, to move raw and processed information throughout a global communications grid, is fundamental to command and control. Inherent in this capability is the idea of universal information availability across different transmission media with different characteristics. The Air Force's information network must have global reach for its normal day-to-day operations as well as the capability to allow an instant surge of connectivity and capacity into a localized theater for mobile and fixed-site users. The latter capability is the most difficult and costly to provide but is a very critical and important tool for tactical theater operations. The functional capabilities necessary to achieve Global Information Exchange are:

Distributed Information Infrastructure -- Providing all mechanisms and services required to allow the commander to craft his C3I information environment, including the ability to establish distributed virtual staffs, to share a common consistent perception of the battlespace, and to construct distributed task teams among sensors, shooters, movers, and command posts.

Universal transaction services -- The ability to move information on demand from network to network or link to link without translation or conversion.

Assurance of Services -- Providing high quality services the warfighter can rely on to be available whenever and wherever needed, can be adapted, scaled, and be projected to meet dynamically changing demands and service capacities, and can be defended against physical and information warfare threats.

Global Connection to Aerospace Force -- Developing and demonstrating technologies for global access to command, control, and intelligence information among warfighting forces.

PHASE I: Provide a report describing the proposed concept in detail and show its viability and feasibility.
PHASE II: Fabricate and demonstrate a prototype device, subsystem, or software program.

PHASE III DUAL USE APPLICATIONS: Many C4I technologies have substantial dual-use potential and will impact competitiveness and performance of the commercial sector as well as the military sector. All solutions proposed must have potential for use/application in the commercial as well as military sector, and potential commercial applications must be discussed in the proposal.

AF98-128 TITLE: Mobile, Adaptive Knowledge Base Decision Agents

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop collaborative software agents that can play an active role in decision-making while solving the challenges of a global, net-based C4I information environment.

DESCRIPTION: Autonomous software components that are active, persistent and can reason and communicate while navigating heterogeneous computing environments are typically considered "intelligent agents." Most agents perform a specific task on behalf of a user but usually they do not interact with others in a collaborative paradigm. They also tend to concentrate on the first phase of decision-making (i.e., searching the environment for information). This topic seeks to build upon agent technology developed by DARPA and Rome Lab and their corresponding access to existing C4I knowledge bases and expand it into the second and third phases of decision-making-inventing, developing and analyzing possible courses of action and then selecting, recommending and communicating the best course of action. Agents need to be accessible from anywhere on the globe and be able to communicate key findings and results to appropriate entities, whether human or other machine agents. Agents may also be lazy in that they do not have to perform all the work themselves; instead, they can take advantage of other agents, information servers or problem solvers. Finally, agents must be adaptable and capable of serving a hierarchy of military users.

PHASE I: Identify and justify a multi-agent technology approach to the decision-making process. The approach must be platform neutral, globally available, and build upon sound commercial technology whenever possible. Provide a report describing the concept and architecture in detail and develop an archetype knowledge base decision agent.

PHASE II: Build an initial system by constructing several such agents and demonstrate these prototype collaborative software agents to evaluate their effectiveness in solving specific C4I problems.

PHASE III DUAL USE APPLICATIONS: Agent technology can augment human decision-making and build upon Internet information. It will have enormous applicability to military and commercial domains in the information age, ranging from law enforcement, finance, education, news delivery and health.

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AF98-130 TITLE: Dynamic Data Mining

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop dynamic and adaptive data mining techniques for designing, developing, and accessing large-scale data/knowledge bases for intelligent information systems. The goal is to produce a dynamic intelligent information system architecture consisting of innovative memory mechanisms, high performance intelligent agent supported architecture innovations and layers of very large data/knowledge bases capable of coordinating, cooperating and negotiating to provide just-in-time information and services.

DESCRIPTION: Investigate high performance computational mechanisms to enhance data mining in massive high performance information data/knowledge bases to support joint efforts of DARPA and Rome Laboratory in technology innovation for the area of intelligent information systems. The growing diversity of different types of data is generating a problem because of the massive size of modern data/knowledge bases. Increased use of video, fax, graphics, images, voice, and textual data make these data types readily available, in different forms, to users. Advanced computational models need to address processing of data at very high speeds (petaops). Adaptive memory techniques in conjunction with advanced data structures could provide innovative ways to both access and store various forms of data/knowledge. Intelligent ways to coordinate various forms of raw data, including restructuring, to discover information, and using new computational paradigms available in emerging high performance computing technology need to be investigated. Optical computing innovations could provide breakthroughs in the area of special purpose architecture enhancements. Graphical tools and machine learning techniques for information discovery require both adaptable and scaleable innovations. Mobile computing designs offer potential for incorporating large information sources within local domains. Research innovations in these areas supporting dynamic data mining technology will help provide ways data should be dynamically structured and stored for efficient retrieval as well as provide adaptable transformation techniques to structure knowledge which can be managed more efficiently so that information can be automatically filtered, manipulated and summarized.

Mechanisms to be investigated include (1) intelligent information rich hyperprogram web agents, (2) advanced adaptable memory design/configurations, (3) electro/optical special purpose architecture enhancements, (4) mobile hand-held computational mechanisms for seamless access, and (3) evolvable data/knowledge base configurations for scalable information aggregation/processing. Technical challenges include unique use of adaptive architectures, dynamic databases, and information integration.

PHASE I: Investigate development of techniques for designing, developing and integrating large-scale active information systems using massive multi-source data rich repositories.

PHASE II: Demonstrate a dynamic adaptable data/knowledge base configuration for very large knowledge bases in appropriate scalable information processing domains/platforms.

PHASE III DUAL USE APPLICATIONS: Phase III will test dynamic information mining tools for rapid knowledge base access and commercialize results of Phase I and II. Rapid accessibility to integrated systems and information increases choices for consumers in both civilian and defense applications. This technology could have a major impact on applications that require integrated decision making and timely and accurate information such as planning/scheduling systems, autonomous vehicles, aircraft operation, hospital life support systems, decision support systems, and personal military command and control.

AF98-131 TITLE: Adaptive Data Fusion Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop an innovative adaptive all-source data fusion technology.

DESCRIPTION: Data Fusion has been defined (Joint Directors of Laboratories (JDL), Technology Panel on C3 (TPC3), Data

Fusion SubPanel (DFSP)) as: "Information processing that deals with the association, correlation, and combination of data and information from single and multiple sources to achieve refined position and identity estimation, complete and timely assessments of situations and threats, and their significance in the context of mission operation. The process is characterized by continuous refinement of its estimates and assessments, and by evaluation of the need for additional sources, or modification of the process itself, to achieve improved results." Current data fusion techniques beyond Level-1(correlation) are mainly manual and cannot keep pace with the highly mobile, dynamic forces likely to be faced in the future. Current Level-1 fusion techniques only support limited sources, not all-source information. In addition, adaptive data fusion is currently not available. This topical area will address advanced computing technologies for adaptive data fusion.

PHASE I: Investigate advanced computing techniques (e.g., statistical, artificial intelligence, artificial neural networks, fuzzy logic) applicable to adaptive data fusion. Phase I will result in a detailed plan and prototype software, which demonstrates the feasibility of a potential Phase II effort.

PHASE II: Design and develop the advanced computing techniques applicable to adaptive data fusion as recommended in Phase I, and then prototype a subset of the design to demonstrate adaptive data fusion functionality.

PHASE III DUAL USE APPLICATIONS: Phase III will fully implement and demonstrate the advanced computing techniques applicable to adaptive all-source data fusion, as recommended in Phase II prototype. This topical area has dual-use potential wherever data from different (or even similar) sources are required for decision making, especially when various fusion parameters need to be adjusted for optimal results. Examples of potential industries include: drug enforcement/interdiction, medical, environmental, aerospace, automotive, and manufacturing.

AF98-132 TITLE: Automatic Video Scene Model Generation

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop techniques to automatically model source video features and integrate into an immersive Distributed Interactive Simulation (DIS)/High Level Architecture (HLA)-compatible simulation.

DESCRIPTION: An inherent data compression opportunity relative to video data employs representing objects depicted in a video data stream using polygonal models. This effort will research and develop a prototype capability that can extract 3D objects from video and automatically generate their associated polygonal representations that can be subsequently integrated into a virtual reality (VR) simulation. The image processing that is responsible for the object extraction shall be accomplished real-time, permitting a minimal processing latency. The DIS/HLA-compatible model insertion will be spatially correlated to the represented real-world terrain. Techniques that address multiple fidelity resolution depiction shall be addressed and employed in the demonstration.

PHASE I: The proof-of-concept capability shall be targeted for the SGI UNIX environment and shall be demonstrated using the New World Vistas Global Awareness Virtual Testbed (NWV GA VTB). (The NWV GA VTB node resides in RL/IRDS, Bldg 240).

PHASE II: The Phase I prototype capability will be refined and extended such that it can be demonstrated on a PC-based platform utilizing a Virtual Reality Modeling Language (VRML)-based environment.

PHASE III DUAL USE APPLICATIONS: Aerial Surveys/Mapping; Architectural Engineering, Medical Imaging, VR Entertainment, as well as the aforementioned disciplines utilizing the Internet to interactively disseminate their information.

AF98-133 TITLE: Cross-Platform Collaboration

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop a prototype demonstration allowing for multi-media and desktop video across multiple platforms and Operating Systems.

DESCRIPTION: Current desktop video collaboration is available for specific platforms such as PC's and UNIX machines with the same operating system. Users trying to collaborate with each other cannot do so if using different operating systems or platforms, such as with UNIX systems, Macintoshes and IBM compatible PC's. This effort will develop the initial translation software package to allow cross platform access.

PHASE I: Initial translation functions will be developed for voice, text, video and graphics to be viewed, edited and discussed across several platforms. This tool should allow a user to collaborate with another user on a different operating system

passing text, video, graphics and voice information. In Phase I, the amount of translation software may be limited due to the amount of handling translations among two different platforms and necessary hardware to show the feasibility of the technology being pursued.

PHASE II: The Phase I prototype will be further developed to handle a much broader base of platforms such as Windows NT, Solaris 2.5, Mac OS, and Windows 95 OS. Additional algorithms and handling techniques will be addressed. Additionally, data retrieval among several data bases will be looked into. Also, a more complete graphical user interface will be developed to allow the users to collaborate more efficiently.

PHASE III DUAL USE APPLICATIONS: A fully functional product for collaboration of several users with textual information, graphics, voice, and desktop video on several major platforms and Operating Systems will be the end result of this SBIR. This technology has application to many areas including, publishing, analysis, information exchange, and virtual conferencing, in the medical community, financial domains, and education.

AF98-134 TITLE: Defensive Information Warfare Technology

CATEGORY: Advanced Development; Command, Control, and Communications (C3)

OBJECTIVE: Develop state-of-the-art Defensive Information Warfare technologies by providing innovative research in information systems recovery, and computer data forensics.

DESCRIPTION: Information systems are used for a variety of reasons. In some cases, the reasons are to commit malicious acts. These acts result in damage to the information systems as well as intentional damage to the perpetrators own system upon arrest. The ability to recover, both from the damage caused the perpetrator and the perpetrators information systems is critical to stopping these activities.

PHASE I: Define and propose the development of Defensive Information Warfare technologies and capabilities for use within existing and future information systems. Rudimentary proof of concept prototypes should be developed to demonstrate the ideas proposed.

PHASE II: Design, develop, and implement a prototype demonstrating the proposed concept or technology. This prototype should be consistent with the philosophy of the Air Force and focus primarily on COTS based information systems.

PHASE III DUAL USE APPLICATIONS: Technologies developed should have the widest global applicability to both AF and commercial information systems. The Air Force is quickly adopting COTS as the primary information system medium and, therefore, commercialization of the non-military specific portion of the Defensive Information Warfare technologies or concepts should be highly desirable.

AF98-135 TITLE: Adaptive Signal Processing Algorithm Development for Airborne Early Warning Radar

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Investigate and develop software solutions to the deficiencies of high Pulse Repetition Frequency (PRF) waveforms in terms of detection performance of low cross section/low velocity targets for pre-beamformed Airborne Early Warning (AEW) Radar data.

DESCRIPTION: Returns from a high PRF Airborne Early Warning (AEW) Radar can contain a certain type of clutter return that can mask slow moving targets of interest such as helicopters and small private aircraft. This clutter phenomenon is known as J-hook clutter. Rome Laboratory has demonstrated the corruptive effects of near range clutter illuminated with a high PRF waveform from a multi-channel AEW radar. Such waveforms create a clutter ridge that forms across several range/Doppler cells producing what is referred to as the clutter hook. This hook can occupy the same range/Doppler space as a target of interest.

PHASE I: Derive theory behind the J-hook clutter effect and define potential problems involving detection of low velocity/low radar cross section targets. Provide a report describing the proposed concept.

PHASE II: Develop Signal processing solutions that accept pre-beamformed AEW data and detect low velocity/low radar cross section targets hidden in the J-hook clutter.

PHASE III DUAL USE APPLICATIONS: This technology will be useful for drug enforcement, that utilize AEW type platforms, by providing the capability to detect small aircraft flying "low and slow" carrying contraband into the United States and Canada.

AF98-136 TITLE: Advanced Techniques for Video Indexing and Retrieval

CATEGORY: Advanced Development; Command, Control, and Communications (C3)

OBJECTIVE: Develop techniques to efficiently index video for subsequent retrieval and exploitation by an analyst.

DESCRIPTION: Video imagery collection, exploitation, and dissemination is becoming increasingly important in the intelligence community. Video data provides enhanced opportunities to detect and identify fixed and mobile targets, yet compounds the problem of automated indexing and retrieval of relevant data for intelligence analysts. This effort will develop efficient, real-time techniques for fully automated processing of video data. These techniques will allow analysts to quickly retrieve and analyze the segments of video that are relevant to the objectives of a particular mission.

PHASE I: Develop techniques for automated indexing, retrieval, and efficient visualization of video clips for intelligence analysts.

PHASE II: Develop a prototype application which will allow efficient access to medium to large set of video data, and can be integrated with existing information databases.

PHASE III DUAL USE APPLICATIONS: Techniques and tools developed under this effort have application to digital video libraries and image/video repositories.

AF98-137 TITLE: Optical Memories

CATEGORY: Advanced Development; Computing and Software

OBJECTIVE: Identify and characterize candidate media, lens architectures, or beam steering concepts to provide storage capacities of at least 1 Gigabit/cm3 or at least 1 Megabit/cm.

DESCRIPTION: This effort seeks to exploit the recent advances made in the field of nano-technology in order to increase bit storage density. Organic polymers, synthetic DNA, and covalent transition metal compounds all have shown the potential to increase storage densities by orders of magnitude. The challenge is to fabricate them on a nano-scale and then optically address (write/read) them at room temperature. The associated optical write/read system should also take advantage of the advances that industry has made in lasers, lens design, spatial light modulators and other components.

PHASE I: Concept definition with experimentation adequate for feasibility demonstration.

PHASE II: Designing, fabricating, and testing of a brassboard.

PHASE III DUAL USE APPLICATIONS: Phase III would involve the generation and implementation of marketing plans for commercializing the technology developed under Phase I and II. High density mass storage would impact every business from entertainment to medicine. Imagine 4000 hours of audio, or all the x-ray films of a large metropolitan hospital, stored on a device the size of a sugar cube. The development of this technology would benefit users from the Library of Congress to the records department of insurance companies.

AF98-138 TITLE: Electro-Optic Data Transport for Optical Memories

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop hardware, software and/or network protocols which will allow successful integration of various three-dimensional memories into existing single (or multiple) processor network architectures.

DESCRIPTION: Emerging three-dimensional memories such as two-photon absorption and holographic memories read and record data in two-dimensional blocks (pages) of digital data. It is projected that these systems will yield aggregate data rates on the order of 1-10 Gb/s. One area of growing interest involves optimally utilizing these inherently parallel memory in traditional serial network scenarios. This should be done in a way that maximizes the net throughput rate to all users, while minimizing system complexity. The problem can be broken up into three different areas. First, hardware issues are of great interest. Traditional electronic transmission lines may not work well at these data rates. Fiber optics have shown a lot of promise in this area, as shown by the newly designed HIPPI-6400 standards. Free space optics may be a long term solution as well, not only for their very high data bandwidth, but also since they can be used for parallel processing applications. Second, software issues become critical in terms of manipulating

these large pages of data. Tied closely to this are data protocol issues. This includes optimizing the parallel-to-serial conversion to minimize data bottlenecking, finding the optimal block size to perform error corrections, selecting optimal page sizes, etc.

PHASE I: Investigation of the problem using state of the art memory and network parameters as benchmarks.

PHASE II: Expand on the Phase I results by developing and fabricating the hardware and/or coding the software. This should result in a functional demonstration system.

PHASE III DUAL USE APPLICATIONS: Phase III would consist of taking the results of the Phase II effort and transitioning them into a fully commercial product. This technology is critical to the integration of large scale parallel access memories to existing single/multi- processor environments. In addition, it is expected that the results of any effort in this area will be applicable to the fields of optical computing and optical communications.

AF98-139 TITLE: Monitoring and Management of Distributed Information Infrastructure

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: The objective of this effort is to identify and develop monitoring and management techniques and mechanisms for DOD Distributed Information Infrastructure.

DESCRIPTION: The advent of broadband communications deployed with fiber, wireless, fixed and mobile assets provides the capability to establish decentralized and distributed information systems that support millions of DOD, commercial, and academia users simultaneously. To effectively utilize the aggregate computational power represented by the sum of these resources, information and network management systems must provide functions and capabilities required to monitor and manage their processing, storage, and communication network resources.

PHASE I: Investigate resource allocation and apportionment mechanisms to control execution of tasks in an object oriented distributed computing system as defined by the Object Management Group/Object Management Architecture (OMG/OMA) standards. Investigate, and identify multi-level Network Management Systems mechanisms that operate in a cooperative manner to provide hierarchical, peer-to-peer, summary level, and component level network management across multiple user domains. Mechanisms should consider available information system resources (processing, storage), available communication network resources (bandwidth) and user requirements (deadlines, level of effort, scope, security, etc.)

PHASE II: Implement either all or a subset of the proposed services into a selected OMG/OMA environment. Construct monitoring and management mechanisms at the information system and communication network layers that interpret the current environment state and execute changes to the information system and network to accommodate given user tasks and requirements.

PHASE III DUAL USE APPLICATIONS: The developed mechanisms will provide monitoring and management for Distributed Information Infrastructure(s) and provide a common operating picture, with reduced manning and logistics for deployed military Command and Control resources. This technology also has broad application to the telephony and data communications industries who provide information system and communication network services.

AF98-140 TITLE: Advanced Tools for Information Warfare

CATEGORY: Advanced Development; Command, Control, and Communications (C3)

OBJECTIVE: Identify, organize and develop emerging information technologies for the denial, exploitation, corruption or destruction of an adversary's information and its functions. To protect the integrity of and to enhance the use of our own information operations.

DESCRIPTION: This effort spans a number of enabling technologies for attacking, protecting, modeling, and communicating information. This effort has the potential for diverse products ranging from innovative hardware or software systems and devices for achieving a new information function to software tools for accomplishing a structured information function to a system of signs and symbols to enable a commander to absorb and react to volumes of information which are today beyond human capability.

PHASE I: Define and structure the proposed development in terms of its ultimate military and civilian end products. Rudimentary modeling of the capability in a form suitable for use in wargaming and DIS (Distributed Interactive Simulation) environments is planned.

PHASE II: Design, fabrication, coding and testing of a prototype implementation of the proposed capability in context of and operational exercise.

PHASE III DUAL USE APPLICATIONS: Phase III would involve the generation of the implementation and marketing plans for commercializing the technology developed under Phases I and II. This technology is a double edged sword that could be used both for attacking and protecting information. It is expected that the NII (National Information Infrastructure) will be a burgeoning marketplace for Information Protection technology at the time this development is mature.

AF98-141 TITLE: Synthetic Aperture Radar (SAR) Enhancing Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop algorithms and/or specialized processors to detect (and possibly compensate for) radio frequency interference received by synthetic aperture radars

DESCRIPTION: There are many radio frequency (RF) sources which can inadvertently or intentionally interfere with the operation of a synthetic aperture radar (SAR). Examples include wireless communication, commercial air-control or weather-monitoring radars, and military radars. For a SAR to be most cost-effective, it needs to detect and filter out or compensate for any extraneous RF signals it receives. The purpose here is to better deal with those RF interference sources that are not well handled by the already existing SAR processing algorithms.

PHASE I: Identify those RF sources existing today and potentially available within the next ten years which can inadvertently or intentionally cause significant interference with the operation of SARs. Clearly explain why the current SAR processing cannot adequately deal with these interference sources. Identify potential algorithm and/or specialized processor ideas that would improve SAR performance in the presence of such interference. Develop top-level concepts for these ideas and predict the cost and effectiveness for each of these concepts. Recommend one or more of the concepts for further development in Phase II.

PHASE II: Experimentally test the concept(s) recommended in phase I. Assemble a hardware-in-the-loop simulation of a SAR in the presence of the RF interference sources identified in phase I. In controlled experiments, assess the ability of the new algorithm(s) and/or specialized processor(s) to overcome the interference, over the range of interfering source parameters which reasonably represents what one could expect in an operational environment.

PHASE III DUAL USE APPLICATIONS: SAR imagery from space will be available commercially in the near future from ERS, JERS, and RadarSat. United States companies will want to compete (or team) with these European, Japanese, and Canadian enterprises. The ability to offer a higher quality and/or more robust product would help United States companies in this commercial arena.

AF98-142 TITLE: Innovative Special Operations Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop innovative technologies for the support of Special Operations

DESCRIPTION: Proposals may address any aspect of technologies that will enhance the ability to: (1) detect weapons concealed beneath a persons clothing, (2) tag persons or objects so that their location and status can be positively identified, and (3) perform through-the-wall surveillance (TWS). Recent military operations (i.e., Somalia, Haiti, Bosnia, etc.) have required military forces to guard undeveloped airfields, patrol urban environments, etc. These operations require that military personnel interact with indigenous personnel, most of whom do not represent a threat. Technology to detect concealed weapons, perform tagging and to perform TWS would greatly enhance the ability of military forces to safely and effectively perform these missions. This technology includes sensor systems (i.e., imaging and nonimaging radars, millimeter wave imaging radiometers, etc.) and the signal processing necessary to ensure robust system performance. Signal Processing techniques to combine (fuse) the outputs of multiple sensors is also of interest.

PHASE I: Provide a report describing the proposed concept in detail and show its viability and feasibility.

PHASE II: Fabricate and demonstrate a prototype device, subsystem, or software program.

PHASE III DUAL USE APPLICATIONS: This technology will have substantial dual-use potential and will impact competitiveness and performance of the commercial sector as well as the military sector. One particular dual-use application of this technology is

in the area of law enforcement and corrections. All solutions proposed must have potential for use/application in the commercial as well as the military sector, and potential commercial applications must be discussed in the proposal.

AF98-144 TITLE: Optical Backplane Interconnects for High Performance Computing

CATEGORY: Advanced Development; Computing and Software

OBJECTIVE: Investigate application of high speed optical interconnects for high performance computers in Air Force surveillance platforms, leveraging, and militarizing parallel commercial developments.

DESCRIPTION: High speed signal processing and information storage for C4I is driven by such operational realities as increasing jammer densities against C4 assets, low-observable target surveillance, and handling of large intelligence data bases. Traditional electronics techniques identified to counter the threats have processing requirements which are increasingly prohibitive, outpacing the rate of advance of conventional all-electronic components.

Increasingly widespread industry development and use of optical data links is on the verge of creating a large manufacturing base for low cost opto-electronics interconnects and building blocks such as laser sources, switches, optical connectors, optical transceivers, memory access, and integrated packages. Intensive processing capabilities are made possible by commercial interests and advancements in optical interconnect links and optically influenced architecture designs for high performance computer processors.

There is significant unique opportunity for the DOD to take advantage of previously unattainable fully and multiply connected network topologies, newly available by integrating optical and electronic processor components in the form of electro-optical transceivers, switches, and passive optical interconnects for backplane access and data transfer in the multiple gigabit and terabit range.

Future implementations of next generation signal processors permit significant enhancements in military operational surveillance functions such as automatic target recognition, multiple target tracking, multisensor integration, space-time adaptive processing, and synthetic aperture radar.

PHASE I: Characterize optically realizable backplane and interconnect enhancements to current and near term future commercial high performance computing architectures, particularly those proposed for use in Air Force surveillance platforms.

PHASE II: Assemble components to demonstrate enhanced high performance computer performance, utilizing high speed optically interconnected nodes and processors. Interconnect data transfer capacity should be in the range of several hundred gigaflops (GFLOP) to teraflop (TFLOP) range.

PHASE III DUAL USE APPLICATIONS: Remove speed limitations in all super computer systems for DOD, NASA, other government agencies, and commercial systems.

AF98-145 TITLE: Synthetic Data Prediction and Validation Techniques for Automatic Target Recognition (Atr)

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop innovative radar prediction and geometry modeling and validation techniques for complex target geometry models.

DESCRIPTION: The Air Force is actively pursuing synthetic radar prediction technology for ATR applications. Sensors of interest include High Range Resolution Radar (HRR) and Synthetic Aperture Radar (SAR). Advances in high frequency Radar Cross Section (RCS) prediction techniques and Computer Aided Design (CAD) geometry modeling tools and practices are allowing synthetic predictions of tactical targets to be used in ATR development. However, further improvement in the fidelity of predicted radar data is a critical need for advancing ATR technology. This topic solicits innovative solutions in computational electromagnetic prediction for complex targets, CAD geometry modeling, CAD geometry validation and implicit model building. This effort is interested in advancing the state of the art in electromagnetic prediction techniques for complex target geometry models. Efficient models for second and third order scattering mechanisms, hybrid prediction techniques that explore techniques to merge measured data with static predictions and hybrid techniques for integrating low and high frequency modeling techniques are of interest. Stochastic and perturbation techniques that address the technical challenge of augmenting static deterministic synthetic data to reflect the dynamic nature of ATR scenarios, target configuration variation and target intra-class variability are included. Target geometry models can be provided by Wright Laboratory, Combat Information Technology Division (WL/AAC) for computational electromagnetic model development. Accurate sampling of the target geometry and detailed construction by a specialized modeler are required to build a

CAD geometry model for a complex target body. More efficient and accurate methods to improve the current target modeling process is of interest. Currently, target geometry and materials are obtained from technical sources such as line drawings, blue prints, scale models, photographs, and the actual target body which is a repetitive and time-consuming process. We are interested in techniques that will merge these technical sources with the overall CAD geometry construction process into an automated system tool that will significantly reduce the time to produce ATR models. Sampled points from targets of interest can be provided by WL/AAC for CAD modeling tool development. The validation of synthetic radar data is currently a time-consuming tedious process that involves careful visual inspection of geometry models, detailed synthetic/measured comparisons using appropriate error metrics, and trace-back tools from predicted data back to the geometry model. This process is repeated in a serial fashion over as many spatial sub regions of interest surrounding the target as possible. This topic includes efficient synthetic validation techniques that accommodate ATR algorithm performance evaluation criteria. Innovative data analysis and experimental design techniques that address the validation of an N class target set are of high interest. Data and geometry visualization tools are also of interest. While conventional neural networks construct direct input-output relationships that have minimal response time but require extensive training, humans often construct models quickly from a few observations and can make predictions or estimates with considerable accuracy even with coarse models. Implicit model building based on neural network modeling of observed objects has potential application to be merged with visualization tools.

PHASE I: Concept feasibility for a modeling or validation technique. A prototype of a visualization tool.

PHASE II: Development of a modeling, validation or visualization software tool for ATR development.

PHASE III DUAL USE APPLICATIONS : Synthetic radar modeling techniques developed on this effort have application to large area site modeling for communication system design. Validation data visualization and analysis tools have application to medical image analysis, and CAD model visualization tools have application in manufacturing quality control.

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AF98-146 TITLE: Design Automation for Analog and Mixed-signal Circuits

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop electronic design automation tools and processes that support the design of analog and mixed-signal circuits.

DESCRIPTION: Analog circuits are pervasive throughout modern aircraft and in many systems they contribute to a majority of the life cycle cost. Analog systems are much more costly to develop than their digital counterparts because they can be more complex and because there is very little automation to support the designer. This topic seeks solutions for automation of the analog and mixed-signal design problem and seeks tool support in both the time and frequency domain for the emerging VHDL-AMS language. Duplication of capabilities that are already commercially available are strongly discouraged.

PHASE I: The preliminary design of the tool will be performed. The functionality, user interface, and design environment interface will be completely specified.

PHASE II: The tool will be constructed, evaluated, and demonstrated. Reference manuals and user guides will be developed.

PHASE III DUAL USE APPLICATIONS: All tools developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems such as pagers, cell phones, and medical electronics. The tool will be readied for market and tested by potential customers. Production, marketing, and support plans will be developed.

REFERENCE: ANSI/IEEE 1076.1 VHDL ANALOG AND MIXED-SIGNAL EXTENSIONS (VHDL-AMS) PROPOSED STANDARD, http://vhdl.org/vi/analog/

AF98-147 TITLE: Support Technologies for Military Essential Multichip Modules

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop the support technologies required to produce affordable multichip assemblies for military essential applications.

DESCRIPTION: To meet the ever expanding need for increased functionality in advanced military systems requires the use of advanced Integrated Circuit (IC) technologies closely coupled to advanced packaging techniques such as multichip modules, chip on board and three-dimensional packaging. Many of these assemblies contain both analog and digital devices operating in close proximity to one another and must meet stringent size, weight, and power requirements while being able to operate over a wide range of temperatures (-55 degrees C to 125 degrees C). The objective of this topic is to develop the support technologies required to produce affordable multichip assemblies. Areas of interest include, but are not limited to, design tools for mixed mode assemblies, including electromagnetic modeling and simulation tools; known good die; low parasitic interconnects, including microwave dielectric materials for three-dimensional packaging; protective coatings; thermal management techniques; testing methods; and improved assembly techniques.

PHASE I: Determine the initial feasibility of the concept through the design, physical analysis, mathematical modeling, measurements, and, if possible, a prototype.

PHASE II: Develop key processes, validate models experimentally with hardware, explore critical parameters and optimize the design/assembly.

PHASE III DUAL USE APPLICATIONS: Commercial applications that benefit from innovative packaging technology advancements include high performance digital, analog and mixed mode assemblies such as found in computers, wireless communications, automotive and miniaturized diagnostics for the medical industry.

REFERENCE: R.R. Tummala, "Microelectronics Packaging Handbook," 2nd ed, 1997, Van Nostrand Reinhold Semiconductor Industry Association (SIA) "The National Technology Roadmap for Semiconductors"

AF98-148 TITLE: Electronic Countermeasures (Ecm) and Electronic Counter-countermeasures (Eccm) Analysis for Global Positioning Systems (Gps) Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Investigate jamming impacts on GPS and the effectiveness of adaptive antennas to minimize jammer interference.

DESCRIPTION: Growing use of and dependence on GPS applications creates a potential vulnerability to electronic attack (jamming). Exploitation of this vulnerability to deny enemy forces use of GPS provides our forces with a combat advantage. Similarly, the ability to evade or minimize the effects of electronic attack provides increased system reliability and effectiveness. The use of adaptive antennas is one method to protect GPS receivers from jamming. This research will investigate the effects of various jammer signals on GPS applications and the ability of adaptive antennas to minimize or reject jammer interference.

This research will determine the capabilities and limitations of the Wright Laboratory Electronic Warfare Anaechoic Chamber (EWAC) to support the simulation and measurement of GPS and ECM signals. The result will be a plan for actual testing and analysis of ECM and ECCM techniques in the EWAC. Next, measurement of GPS antenna performance against selected jammers will be conducted. Measurements will be taken for both adaptive and non-adaptive antenna patterns in the presence of various jammer signals. Analysis of the results will indicate the effectiveness of various jammer signals and the ability of the adaptive antennas to minimize jammer interference. An effective jammer will then be developed.

PHASE I: Assess capability of conducting tests in EWAC. Design tests for selected combinations of antennas and jammers.

PHASE II: Conduct selected tests. Evaluate effectiveness of ECM and ECCM techniques.

PHASE III DUAL USE APPLICATIONS: Anti-jam and interference suppression in commercial GPS applications.

REFERENCE: Edward Bedrosian and Gaylord K. Hugh, Concept-Level Analytical Procedures for Loading Non-processing Communication Satellites with Non-antijam Signals, RAND, 1996.

AF98-149 TITLE: Cost Estimation for Revolutionary Avionics Payloads for Uninhibited Air Vehicles (Uavs)

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop digital tools to estimate costs of revolutionary avionics payloads for far-term concepts.

DESCRIPTION: The development of revolutionary avionics technologies to enable the affordable and effective use of UAVs in future military missions will be a challenge to both government and industry. Today's UAVs perform primarily surveillance and reconnaissance missions using state-of-the-art sensors and communications subsystems packaged to meet air vehicle size/weight/power constraints. Air Force plans for UAVs show a continuation of the surveillance and reconnaissance missions as well as the addition of communications relay missions in the near-term; these plans also show the addition of suppression of enemy air defenses missions in the mid-term. Other missions such as support jamming, counter cruise missile, and theater missile defense using either armed or unarmed UAVs are also imaginable. Promising, even revolutionary, technologies to mechanize the needed avionics functions will be required. The selection of the avionics functions to perform such challenging missions is driven primarily by the definition of the mission, i.e., the targets, the threats, and the concept of operations (CONOPS). Yet affordability is a major part of the selection process too. The "Battle Labs" recently proposed by the Air Force will be the organizations to address CONOPS definition and issues (one of the six Battle Labs is UAV specific). A complementary capability which is needed is the capability to estimate the cost, both research and development as well as production, of revolutionary technologies, a capability that goes beyond today's historically-based cost modeling. This capability must interact with the CONOPS under development as well as with avionics technology experiments and demonstrations being modeled and simulated to give a complete evaluation of warfighting capabilities and affordability for far-term concepts. In all cases, the detailed design or form of the future concept may not exist.

PHASE I: Investigate and identify features, characteristics, and interfaces for new digital cost tool (s). Identify any existing cost tools that may be expanded. Develop the plan, with schedule, for the development of such an innovative cost estimating tool.

PHASE II: Develop the proposed tool and demonstrate its application to a far-term UAV concept.

PHASE III DUAL USE APPLICATIONS : Advances in the estimating of costs should have multiple applications throughout the commercial world: for research and development as well as production and for revolutionary technologies where no historical data exists. A couple potential examples of such applications are in the areas of both personal and media communications. With the advent of cellular phones, the future prospect of everyone eventually having personal communications network (PCN) "telephone" number has yet to be realized. Technology trade-offs must be made in order to make such a capability affordable for everyone. The second example lies with the recently announced "high-definition" television (HDTV) or "digital" TV. Great potential is forecasted for interactive/integrated modem/computer communications via HDTV (among other ideas) but is a technology/capability that is still nine years away. Again, making the correct technology choices for mass, affordable implementation and marketing will be necessary.

AF98-150 TITLE: Multi-spectral, Multi-functional Laser Sources

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop a laser source which can be switched between functional modes of operation.

DESCRIPTION: Prime power and space are severely limited for airborne electro-optic systems. Integrated system cost is also a key factor. Electro-optic systems are needed which are capable of efficiently performing more than one function. Target ranging, target identification, target designation, missile defense, and communications are all airborne applications of lasers with very different requirements in power, wavelength, modulation, beam quality, bandwidth, etc. A different laser for each application is not going to be viable. Research and development of lasers, which can perform more than one function, is desired. Within this overall objective, specific technologies of interest include but are not limited to coupling multiple resonators to one pump laser, improved quasi-phase matched wavelength coverage to visible and infrared wavelengths, increased energy per pulse output of quasi-phase matched frequency conversion devices, extended wavelength mid-IR coatings with improved robustness, and multiple nonlinear processes for multiple wavelength output. Finally, any multi-function laser source must also operate reliably under the environmental extremes experienced aboard a jet fighter aircraft.

PHASE I: Demonstrate the feasibility of an innovative technique, concept, or device which would lead to a major improvement in multi-functionality.

PHASE II: Demonstrate a complete device suitable for flight testing which incorporates the innovation demonstrated in Phase I. Device performance will be tested under a full suite of environmental extremes including lifetime, failure

modes, and multi-functionality.

PHASE III DUAL USE APPLICATIONS: The technology developed to make a multi-function laser will also be of strong interest for some commercial applications such as medicine where a single laser that could perform more than one medical procedure would be less expensive and save space.

REFERENCE: Trends in Optics and Photonics Volume 1, Advanced Solid Sate Lasers, S. A. Payne and C. R. Pollock eds. (Optical Society of America, Washington DC, 1996)

AF98-151 TITLE: Multi-aperture Tracking and Designation System

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop concepts and components to perform active tracking and designation through multiple distributed apertures.

DESCRIPTION: Advanced concepts for electro-optical systems on-board future aircraft may include multiple conformal apertures through which all electro-optical functions will be accomplished. To accomplish the laser-based functions will require a fiber-optic distribution system capable of linking common laser sources to all of the apertures and relaying the returned energy to appropriate receivers. For the active tracking and designation function, the distribution system must handle 10's of watts average power with peak powers up to 100 megawatts. The wavelength that must be distributed is the laser designator wavelength of 1064 nm. The distribution system must also include the switching network that will allow coupling between the laser source and any of the apertures. The distribution system must also couple to the conformal optical aperture. Methods that will allow the optical aperture to image or distribute laser energy over angles greater than +/- 45 degrees are also solicited. Such methods can include novel optical designs for imaging large fields of regard through apertures of a few centimeters or of novel concepts for switching narrower fields of view over the large field of regard.

PHASE I: Conceptual design, analysis, and proof-of-concept experiments for multi-aperture modules.

PHASE II: Design, fabrication, and demonstration of multiple conformal modules of active tracking and designation system.

PHASE III DUAL USE APPLICATIONS: The switching, coupling, and large angle distribution techniques developed under this effort will have application to fiber optical distribution systems as well as to tactical military aircraft.

REFERENCE: Aviation Week and Space Technology (Aug 19, 1996), p80-81.

AF98-152 TITLE: Avionics Collaborative Engineering

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop virtual engineering and simulation technology for an avionics collaborative engineering environment

DESCRIPTION: The contractor will develop virtual engineering and simulation technologies to enhance DoD productivity and commercial sector competitiveness by advancing web-based desktop collaborative virtual prototyping processes and applications. Proposals should build on the significant technology base existing for electronic systems design Very High Speed Integrated Circuit Hardware Description Language (VHDL), Analog Hardware Description Language (AHDL), joint modeling and simulation (M&S) standards, and other commercial/industry modeling standards. Collaborative Virtual Prototyping (CVP) involves the application of advanced distributed modeling and simulation along with engineering tools in a web-based avionics collaborative engineering environment to support design, performance, and producibility trade-off analyses throughout the entire life cycle of system development. Using CVP, a simulation model, developed in parallel with the hardware or technology development, allows the scientist, engineer, or end user to refine system requirements early in the engineering process. A virtual prototype allows the engineer on the desktop to see the impact of design changes. Trade studies using the model can then be performed throughout development, as an essential part of the systems engineering process. Virtual engineering necessitates research in areas such as: simulation engineering based on visual programming, automated test, automated verification and validation, model based software requirements development, parallel automated documentation, automatic code generation with multiple language support, embedded configuration control, domain specific, expert system assistants and domain specific software structural models.

PHASE I: Identify the enabling realtime or non-realtime technologies for avionics M&S based upon employing web-based intranet approaches , 2) conduct specific experiments to verify critical aspects of the defined concepts, 3) develop a system specification, implementation approach, and demonstration plan. The contractor shall also document the potential for a Phase II follow-on effort.

PHASE II: Accomplish a detailed design, develop the prototype technology and demonstrate the proposed technology in the appropriate Wright Laboratory System Concept and Simulation Division simulation facility. The contractor shall also detail his plan for his Phase III effort.

PHASE III DUAL USE APPLICATIONS: Significant. M&S is an enabling technology and a change in the way of doing business that will have major implications for the commercial and defense sector. Desktop M&S will become a mainstream concept in the design and production of commercial systems. The commercial marketplace will increase for generic simulation techniques, simulation infrastructure, and off-the-shelf components for applications in financial industries, manufacturing, industrial process control, biotechnology, health care, communication and information systems. The aircraft and automotive industries have demonstrated the success of integrated computer assisted design with supporting modeling and simulation to bring products to market quickly. Advances in software and computer technology are making CVP and desktop M&S possible and affordable for the small to medium business. Software development itself is a manpower intensive endeavor. Requirements definition remains a problem area where the user is unable to verbalize what he/she wants in detail. Virtual prototyping of software requirements and modeling of the software is a future growth area in which simulation is used to review completeness of software requirements and functionality.

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AF98-153 TITLE: Electronic Protection (Ep) for Electronically Steered Arrays (ESAs)

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop methods to investigate effects of electronic attack (EA) signals on ESA radars and develop electronic protection (EP) techniques.

DESCRIPTION: The decided advantage of Electronically Steered Arrays (ESAs), in modern fighter aircraft for increasing radar performance is generally understood. The inherent Electronic Protection (EP) features of the ESA requires research to assess the potential vulnerability to electronic attack (EA) jamming. The ability to evade or minimize the effects of electronic attack provides increased system reliability and mission effectiveness. This effort will research advanced electronic protection techniques that can only be implemented with radars incorporating electronically steered array apertures. The Phase I study is the basis for a Phase II for actual testing and analysis of ECM and ECCM techniques against ESA radars. Included in the research will be an analysis based on estimates of ESA antenna performance against current and advanced jammers. Analysis of the results will indicate the effectiveness of various jammer signals and the ability of the ESA antennas to minimize jammer interference. Work would require classified tasks to include the "secret" level.

PHASE I: Analyze electronic protection techniques that will increase the capability of radars incorporating electronically steered arrays.

PHASE II: Design, development and demonstrate advanced EP concepts and algorithms for electronic steered arrays radars.

PHASE III DUAL USE APPLICATIONS: Resulting technology will be applicable to commercial and general aviation. Future commercial aircraft will benefit from interference rejection techniques. Develop Electronic Protection architecture for advanced ESA radar system..

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AF98-154 Title: Innovative Microelectronics Device Development for Military Essential Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Develop innovative semiconductor device technology and demonstrate concept feasibility for military essential applications.

DESCRIPTION: Explore revolutionary new device concepts and conduct feasibility demonstration efforts on devices with potential for high frequency microwave/millimeterwave applications. Examine new devices, device concepts, and advanced semiconductor fabrication technology for high efficiency linear power amplification.

The intention of this program is to examine new device approaches. This will include new and existing devices (Heterojunction Bipolar Transistors (HBTs), Metal Semiconductor Field Effect Transistors (MESFETs), and other very high power performance devices), new and existing device materials (GaAs, InP, InGaP, GaN) and looking into novel fabrication method to improve power amplifier performance for applications such as phased array radar (military) and wireless local area network (commercial). Selection of the demonstration vehicles shall be based on customer's future needs and the availability of suppliers transferring these technologies from a research to a production environment. This program shall be divided into two phases. Device concepts, including material development and fabrication feasibility, shall be demonstrated during Phase I. Functional demonstration vehicles and design of potential products shall be completed at the end of Phase II. It is expected that fabrication capability of commercial and military products will be established by end of Phase II.

PHASE I: Material growth, characterization, and device development shall be completed.

PHASE II: Functional demonstration vehicles and design of potential products shall be completed.

PHASE III DUAL USE APPLICATIONS: Commercial applications include personal telecommunications systems, wireless local area network, automobile sensors, security systems, and intelligent highway systems.

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AF98-155 TITLE: Feature-based Automatic Target Recognition (ATR)

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop feature extraction and feature-based ATR algorithms for radio frequency (RF), electro-optic (EO) and multi-spectral sensors.

DESCRIPTION: The Air Force is actively pursuing ATR technology for surveillance/ reconnaissance (SURV/RECCE), attack and air combat scenarios. Data associated with sensors for this technology are typically of much higher dimensionality than the underlying information content. Therefore, it is desirable to develop feature extraction techniques to reduce the feature set to optimally represent the observed target. Such a technique should increase the robustness of ATR systems by eliminating features that have little discrimination information. Sensors of interest include radar and EO systems. Specifically, SURV/RECCE radar modes of interest include synthetic aperture radar (SAR), 3-d SAR and moving target high range resolution (HRR). The Air combat sensor of primary interest is HRR radar. EO and multi-spectral (EO&MS) sensors are primarily considered for air-to-ground (A/G) SURV/RECCE and attack. Both active and passive EO&MS systems are of interest. The development of ATR algorithms, based

on the extracted features, is required. The feature based ATR algorithms considered may be based on target/sensor physics (such as model based vision), statistical pattern recognition or learning based systems. Systems most desirable will accrue evidence and uncertainty from the feature set to obtain target recognition. In accruing information, a proposer may choose to fuse information from several sources to enhance ATR performance and robustness. ATR fusion options of interest may include, but are not restricted to, fusion of SAR and HRR or SAR and EO&MS for SURV/RECCE, unmanned autonomous vehicles (UAVs) and fighter platforms. For air combat ATR systems, fusion of HRR with other radar modes (such as electronic signal modulation (ESM) and passive non-cooperative target identification techniques) is of interest. Data for the development and testing of the feature extraction and ATR algorithms will be available from WL/AAC. This data includes measured SAR data from several ground vehicles, a limited set of measured A/G HRR for moving ground targets, a large set of HRR for air targets and XPATCH synthetic data corresponding to the measured data. An extensive A/G EO data set is available as well as Advanced Electro-Magnetic Model for Aerial Targeting (AEM*AT) simulation codes and limited multi-spectral data.

PHASE I: Explore new feature/algorithm techniques. This may be based on synthetic data for proof of concept.

PHASE II: Advanced development of techniques and evaluation with measured data.

PHASE III DUAL USE APPLICATIONS: Object recognition technology is applicable to a wide array of commercial areas including facial and speaker recognition for advanced security monitoring systems, automated non-destructive industrial inspection for defective product rejection and intelligent robotic vision for manufacturing automation.

REFERENCES:

1. D. J. Andersh, M. Hazlett, S. W. Lee, D. D. Reeves, D. P. Sullivan and Y. Chu, "Xpatch: a high frequency electromagnetic-scattering prediction code and environment for complex three-dimensional objects," IEEE Trans. Antennas Propagation. Mag., vol.36, pp.65-69, 1994.

2. R. Mitchell, "Overview of high range resolution radar target identification", Conference proceedings of the 1994 Automatic Target Recognition Working Group, Monterey, CA.

3. ATR Performance Evaluation - W. Eric Grimson, "The Combinatorics of Heuristic Search Termination for Object Recognition in Cluttered Environments," IEEE PAMI Trans, Sep 1991.

4. Physics-Based ATR - R. Kapoor and N. Nandhakumar, "A Physics-Based Approach for Detecting Man-Made Objects in Ultra-wideband SRA Ima gery," Proc. IEEE Workshop on Physics-Based Modeling in Computer Vision. IEEE Computer Society Press, 1995.

5. Tamburino, L.A., M.M. Rizki, M.A. Zmuda, "Generating Pattern Recognition Systems Using Evolutionary Learning, IEEE Expert, June 1995, pgs 63-68.

AF98-156 TITLE: Solid State Radio Frequency (Rf) Electronics Applied Research

CATEGORY: EXPLORATORY DEVELOPMENT; Electronics

OBJECTIVE: Explore innovative RF device and component technologies, and demonstrate concept feasibility for military sensor applications.

DESCRIPTION: Investigate promising new microwave and millimeter wave circuit and component technologies with the potential to reduce the cost, weight, and volume and increase the reliability/ performance of military RF systems. Candidate technologies include microwave and millimeter wave solid state devices, monolithic integrated circuits, computer-aided design/ characterization techniques, device and circuit fabrication, power and low noise amplifiers, signal control components including miniature tunable filters, mixed mode RF/digital ICs, and low cost millimeter wave phased array technologies. Emphasis will be placed on the development of technologies which reduce size, weight, and cost through improved fabrication and higher levels of integration and which are amenable to accurate modeling for improved design and simulation. Candidate CAD technologies include, but are not limited to, various computational intelligence methods encompassing: neural networks, fuzzy logic, genetic algorithms, evolutionary programming, and adaptive reasoning systems. Both hardware and software implementations will be considered.

PHASE I: Select certain RF device technologies or RF device CAD rapid/design prototyping technologies and develop the initial design of these components or CAD design/rapid prototyping methods.

PHASE II: Develop the actual devices or CAD design/rapid prototyping approaches explored in Phase I.

PHASE III DUAL USE APPLICATIONS: Commercial applications that will benefit from innovative electron device technological advancements include high temperature RF transmitters and mixed mode integrated circuits (ICs) for personal communications, automotive collision avoidance/warning, and radiometric sensors for the medical industry.

REFERENCES:
1. D. Hill, A. Khatibzadeh, W. Liu, T. Kim, P. Ikalainen, "Novel HBT with Reduced Thermal Impedance," Microwave and Guided Wave Letters, Vol. 5, No. 11, Nov 1995
2. B. Bayraktaroglu, J. Barrette, L. Kehias, C.I. Huang, R. Fitch, R. Neidhard, R. Scherer, "Very High Power Density CW Operation of GaAs/AlGaAs Microwave Heterojunction Bipolar Transistors," IEEE Electron Dev. Lett., Vol 14, No. 10, Oct 1993, p.493-5.
3. A. Zaabab, Q. Zhang, M. Nakhla, "A Neural Network Modeling Approach to Circuit Optimization and Statistical Design," IEEE Trans. Microwave Theory and Tech., Vol. 43, No. 6 June, 1995, pp 1349-1358.
4. G. Creech, J. Zurada, P. Aronhime, "Feedforward Neural Networks for Estimating IC Parametric Yield and Device Characterization," Proceedings of the IEEE International Symposium on Circuits and Systems, Seattle WA, April 30-May 3, 1995, Vol. 2, pp 1520-1523.
5. J. Eldredge, B. Hutchings, "RRANN: The Run-Time Reconfiguration Artificial Neural Network," Proceddings of the IEEE Custom Integrated Circuits Conference, San Diego CA, May 1-4, 1994, pp 77-80.

AF98-157 TITLE: Frequency Hopping (Fh) Signal Prediction and Countermeasures

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Investigate techniques for detecting, identifying, and jamming FH signals.

DESCRIPTION: Advances in and use of low-probability-of-intercept (LPI) spread-spectrum signals presents the Air Force with increased difficulty in detecting, identifying, and jamming hostile communicators. FH signals are a subset of LPI signals whose use is spreading rapidly in tactical communication due to their ease of implementation. The ability to intercept and identify non-cooperative communicators provides the military with a combat advantage. This program will develop and implement techniques which can detect and predict the FH signaling scheme used by a non-cooperative communicator. The technique should attempt to identify the FH signal in the shortest amount of time and using a minimum of a-priori knowledge. In addition, once a signaling scheme is identified, a suitable jamming technique should be identified. The research should include a trade-off analysis of the amount of a-priori knowledge of the FH signal required and the effectiveness of the developed technique.

PHASE I: Define a viable approach to detecting, identifying, and jamming an advanced FH communication signal including applicable time, design hardware architecture, and a-priori knowledge trade-offs.

PHASE II: Optimize and demonstrate the approach through analysis, simulation, hardware, and testing.

PHASE III DUAL USE APPLICATIONS: Resulting techniques have application to law enforcement and drug interdiction.

REFERENCES:
1. D. Curtis Schleher, Ph.D., "Introduction to Electronic Warfare", Artech House, 1986, ISBN: 0-89006-142-4.
2. David L. Nicholson, "Spread Spectrum Signal Design - LPE and AJ Systems", Computer Science Press, 1988, ISBN: 0-88175-102-2.

AF98-158 TITLE: Combat Identification (Cid) Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop new and innovative techniques for CID of air or surface targets.

DESCRIPTION: The Air Force is actively pursuing CID capabilities for use in modern fighter aircraft. Current capabilities are not robust and require significant pilot attention for positive CID. The Vincennes Disaster, Desert Storm, and Operation Deny Flight have demonstrated the critical need to positively identify air and surface targets. The destruction of hostile targets while preserving non-combatant, neutral, and friendly aircraft remains a top priority. Identification must positively declare aircraft/vehicle type to enable high-confidence engagement decisions. Class level declarations, whether cooperative or non-cooperative, may be considered viable components of a type level CID system of systems. The primary sensor for CID is radar with an emphasis on airborne tactical radar systems. These systems allow the active or passive collection of multi-mode electromagnetic data which might prove suitable for CID exploitation. CID of air targets is currently performed by signature pattern matching or by performing specialized processing to the radar signature. Other target information in the returned radar signal that is ignored or lost due to advanced processing may provide additional features and characteristics improving overall CID. Similarly, programs exist that provide algorithms and data for stationary ground target location and ID as well as high range resolution algorithms and techniques for detection of ground

moving targets. In both cases, there are no all-inclusive predefined sets of exploitable electromagnetic features. Any process which would yield a robust, high-confidence feature or capability by using either single-mode or fused information can be examined. For example, this information may include complex vibratory or target feature inter-relationships.

PHASE I: Investigate and identify features, characteristics, and innovative informational relationships for target identification. Based upon these results, develop concepts for radar signature exploitation, CID algorithm designs, and performance evaluation.

PHASE II: Develop the radar signature exploitation CID algorithm.

PHASE III DUAL USE APPLICATIONS: Advances in target identification has applications in drug interdiction, air traffic control, industrial inspection, manufacturing automation, and automated security.

REFERENCE: Cranos, Roger, "Combat Identification In The Future: Maintaining a Balance", presented at the Society of Photo-Optical Instrumentation Engineers (SPIE) 11th Annual International Symposium on Aerospace/Defense Sensing, Simulation and Controls, 20-25 April 1997.

AF98-159 TITLE: Unique Sensor Concepts for Infrared Multispectral Imaging

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop innovative infrared multispectral imaging sensor designs for long range day/night tactical and reconnaissance applications.

DESCRIPTION: Infrared targeting systems, based solely on spatial and thermal detection phenomenology, are fundamentally limited in performance for several important scenarios: extended ranges, wide area search, low contrast conditions, and deep hide and camouflage, concealment, & deception (CC&D) targets. Multispectral discrimination presents an opportunity for significant enhancements in target detectability by exploiting characteristic target spectral (color) features and high background spectral correlation.

Results to date under the current program, Brassboard Airborne Multispectral Sensor System Specification (BAMS), have supported this potential of multispectral sensing through extensive spectral measurements and subsequent performance measurements over a range of targets, backgrounds, and environmental conditions. The BAMS program is part of a tri-service research area called the Joint Multispectral Program (JMSP). Other research within JMSP includes developing automatic- target cueing (ATC) and automatic target recognition (ATR) algorithms. The performance goals are high probability of detection (> 90%), low false alarm rates (< one per 100 square km) and area search capabilities greater than 10 square km/ minute. The sensor designs should provide the above performances with minimum system cost.

As part of the BAMS program, spectral sensor design trades are being refined based on an expanded target/background database. These trades include sensor parameters such as: spectral bands, spectral bandwidths, noise equivalent spectral radiance, band-to-band registration, etc. The output of the effort is a better understanding of the sensor system design trades that result in an operational multispectral sensor capable of supporting the requirement for automatic precision targeting.

The objective of this topic is to develop approaches for a affordable, calibrated, optically-registered multi-band image system using available focal plane arrays. These approaches must focus on satisfying the sensor system requirements for high probability of detection and low false alarm rate performance automatic cueing and be compatible with missions from high altitude reconnaissance unmanned vehicles and manned fighters flying above 10,000 ft altitude. Modular sensor designs that provide the required performance from 10-65k ft altitudes in both manned and unmanned vehicles are desired.

PHASE I: Design a thermal multi band sensor based on performance trades using existing thermal spectral data and state of the art algorithms. Sensor designs shall be provided based on meeting the desired performance and cost goals.

PHASE II: Optimize and complete the design for the selected sensor. This phase will include testing of critical components in order to prove the concept feasibility and reduce risk.

PHASE III DUAL USE APPLICATIONS: Many non military target spectral signatures are of interest in the thermal region. Dual use of this sensor is desired for oil and mineral exploration as well as pollution and environmental monitoring.

REFERENCE:
1. Eismann, M. T., Schwartz, C. R., "Focal Plane Array Nonlinearity and Nonuniformity Impacts to Target Detection with Thermal Infrared Imaging Spectrometers." Infrared Imaging Systems: Design, Analysis, Modeling, and Tasking VIII, Proceedings of the SPIE, vol. 3063, Orlando, FL, 3063-14 (April 1994).
2. Eismann, M. T., et al, "Infrared Multispectral Target/Background Field Measurements," Signal and Data Processing of Small

Targets, Proceedings of the SPIE, vol. 2235, Orlando, FL, 2235-09 (April 1994).
3. Eismann, M. T., et al, "Target Detection in Desert Backgrounds: Infrared Hyperspectral Measurements and Analysis," Signal and Data Processing of Small Targets, Proceedings of SPIE, vol. 2561, San Diego, CA (July 1995).
4. Schwartz, C. R., et al, "Target Detection Using Infrared Spectral Sensors," Imaging Spectrometry II, Proceedings of SPIE, vol. 2819, Denver, CO, 2819-23 (August 1996)
5. Bongiovi, R. P., et al, "Airborne LWIR Hyperspectral Measurements of Military Vehicles," Proceedings IEEE Aerospace Applications Conference, Aspen, CO (February 1996).

AF98-160 TITLE: Precise Image Calibration and Alignment (PICA)

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop methods to provide enhanced accuracy reference information for precise image calibration, alignment, and correlation for multi-platform operations.

DESCRIPTION: The recent history of precise aircraft reference systems has been to create continually higher levels of physical, functional, and informational integration within the onboard navigation/reference system, between that system and other onboard systems, and with the crew. These levels of integration have been developed in response to stringent performance requirements of onboard mission sensors such as Synthetic Aperture Radar (SAR) or Electro-Optic (EO), and the need to calibrate, align, harmonize and fuse their data. In the future, information integration across multiple platforms (airborne, orbital, ground- based, and sea-based) will provide increased combat effectiveness through faster, more flexible, more precise targeting and attack, battlefield management, resource and environmental monitoring, and battle damage assessment. Sources of this information include E-3A (AWACS) and E-8 (JSTARS) aircraft, national assets, Unmanned Air Vehicles, and reconnaissance platforms, as well as combat aircraft. Potential users of the information include combat aircraft, special operations aircraft, transport aircraft, ground based systems and personnel, ships, missiles, and C2 nodes. The focus of the Precise Image Calibration and Alignment (PICA) program will be on current reference systems' capabilities to support the calibration, alignment, and correlation of multiple source imagery and to make use of supporting information, such as enhanced accuracy digital terrain and feature data for multiple platform scenarios. The technology developed under this program will contribute directly to the overall objective of identifying, developing, and evaluating the reference systems technologies that are needed to support the theater-wide sharing and fusing of both on-and off-board information for future combat aircraft.

PHASE I: Using requirements determined under previous Theater-wide Reference Information (TRIM) programs (i.e., Information Management for Theater-wide Reference Systems, Common Reference Frame, Precise Reference Information State Error Measurement and TRIM), Phase I of the PICA program will consist of an assessment of state-of-the-art reference systems' capabilities to support current and emerging multi-sensor/multi-platform image correlation and alignment. Analysis and simulation will be used to identify required reference systems technology enhancements/developments and to demonstrate how those developments would improve image calibration, correlation, and alignment.

PHASE II: Develop and demonstrate techniques and algorithms identified under Phase I for enhancing reference systems technology and for applying those enhancements to meet multi-platform requirements for precise image calibration, alignment, and correlation. This demonstration system will consist of models of the sources and users of the imagery and digital terrain and/or feature data during a specific, realistic mission scenario. Assessment of reference systems technologies developed will be performed using such metrics as targeting error, errors in detecting and discriminating targets and threats, and computational improvements in calibration, correlation, and alignment algorithms.

PHASE III DUAL USE APPLICATIONS: Dual-use applications include environmental and geophysical monitoring which would require mutual registration of imagery or digital terrain data from varied sources such as onboard resources, other airborne platforms, overhead assets, and fixed ground sites.

REFERENCE:
Berning, S., Howe, P., Jenkins, T. "Theater-wide Reference Information Management," Proceedings of The National Aerospace and Electronics Conference (NAECON) 1996.

AF98-161 TITLE: Very High Speed Integrated Circuit Hardware Description Language (Vhdl) Models for Backplane Open System

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a set of VHDL models to support backplane open system architectures in new and replacement avionic developments.

DESCRIPTION: In order to reduce the cost of sustaining its warfighting capabilities, the Air Force is continually driving toward the use of commercial standards for its electronic equipment. Backplane Open System Architecture standards such as the "PCI" and "VME" busses will be used more and more to support heterogeneous processing clusters consisting of commercial processors, Application Specific Integrated Circuit-based custom processors, FPGA-based reconfigurable computers, memories, and standard and non-standard peripheral interfaces. A set of VHDL (ANSI/IEEE 1076 standard) models is needed to support top-down design and virtual prototyping of systems with these industry standard busses. The set must include: a) performance (or network architecture) level models that indicate system oriented timing details for bus selection and implementation trade-offs; b) functional models which describe the function without timing for virtual prototyping, c) interface models which describe the port structure, the function, and the timing details for virtual prototyping, module and backplane design, and d) a synthesizable register-transfer level model which would be used to design a custom interface circuit. Test vectors would be developed and marketed that support all of the models.

PHASE I: The preliminary design of the models will be performed and specified.

PHASE II: The models and test vectors will be constructed and verified. Reference manuals and user guides will be developed.

PHASE III DUAL USE APPLICATIONS: All models developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems. These backplanes are also used in indujstrial and medical electronic systems.

REFERENCE: ANSI/IEEE 1076 VHSIC HARDWARE DESCRIPTION LANGUAGE (VHDL) REFERENCE MANUAL ANSI/IEEE

AF98-162 TITLE: Design Technologies for Re--engineering and Re-design of Legacy Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop electronic design automation tools and processes to reduce the time and cost of re-engineering and re-designing avionics.

DESCRIPTION: In order to sustain its warfighting capabilities the Air Force is continually upgrading its electronic equipment to more modern integrated circuit technologies. This is presently a costly, error prone process which is primarily done manually. This topic solicits design automation technology that aids in re-capturing and re-engineering existing designs and their test sets into a VHDL format such that modern design automation tools can be utilized to rapidly design upgrades and replacements for avionics. The research proposed should have the potential to save thousands of dollars on AF system modernizations. Duplication of capabilities that are already commercially available or that are already receiving significant investment by the DOD are strongly discouraged.

PHASE I: The preliminary design of the tool will be performed. The functionality, user interface, and design environment interface will be completely specified.

PHASE II: The tool will be constructed, evaluated, and demonstrated. Reference manuals and user guides will be developed.

PHASE III DUAL USE APPLICATIONS: All tools developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems. Industrial, automotive, communication and medical electronic systems also have parts obsolescence problems.

REFERENCE: ANSI/IEEE 1076 VHSIC HARDWARE DESCRIPTION LANGUAGE (VHDL) REFERENCE MANUAL ANSI/IEEE

AF98-163 TITLE: Hardware/software Co-design - Co-simulation, Co-specification, Co-synthesis

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop electronic design automation tools/processes that simplify and reduce the time/cost of engineering hardware/software.

DESCRIPTION: Traditionally this has been a labor intensive and often error-prone process with very little automation support or active research. It impacts all electronics based Air Force Systems. For complex electronic systems with multiple processors, it is currently quite difficult to partition, trade-off candidate processor and interconnect implementations, create the hardware and software designs, and to verify correctness of the design prior to physical implementation and integration. This topic solicits design automation tools and processes that significantly address these difficulties. Duplication of capabilities that are already commercially available or that are already receiving significant investment by the DOD are strongly discouraged.

PHASE I: The preliminary design of the tool will be performed. The functionality, user interface, and design environment interface will be completely specified.

PHASE II: The tool will be constructed, evaluated, and demonstrated. Reference manuals and user guides will be developed.

PHASE III DUAL USE APPLICATIONS: All tools developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems. They are applicable to all consumer and industrial electronics.

REFERENCE: ANSI/IEEE 1076 VHSIC hardware description language (vhdl) reference manual ANSI/IEEE

AF98-164 TITLE: Digital Receivers for Global Positioning Systems (GPS)

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop a Digital Multifunction Sensor System for advanced airborne platform.

DESCRIPTION: GPS systems are on the verge of revolutionary advancements due to advancements in apertures, miniature filters, direct digital synthesis, analog/digital converters, amplifiers, and mixers. These advances are due to materials, packaging, interconnect, sealing, chip compaction and process control improvements due, in large part, to transmit/receive module development and commercial processor chip developments. This program will explore applications of new technologies based on anti-jam requirements and other constraints to meet our far-term vision of Direct Digital GPS. Enabling sciences have advanced from Material, Engineering and Mathematical sciences, such as Statistics (Estimation Theory), Numerical Techniques (Adaptive Processing), and Communication Theory (Intermediate Frequency Sampling). Thus, the combination of enabling science and technology gives hope/confidence that an all digital multifunction Radio Frequency sensor suite will be accomplished and that this effort will allow us to begin to understand the research required and technology needs associated with this vision.

System Concept: Strategies for developing those technologies required to achieve an all-digital GPS system, system and concept of operation studies to determine maximum anti-jam capability, and survivability through simulation analysis. These studies and analyses will attempt to balance cost of ownership (i.e., acquisition, operating, and support costs) installation, and performance constraints.

PHASE I: Research and define a Direct Digital GPS System or Subsystem including applicable technology trades, performance and cost trades.

PHASE II: Define systems interfaces for platform applications and build and test critical sub-systems.

PHASE III DUAL USE APPLICATIONS: This technology could be utilized in general aviation for low cost, lightweight navigation or as a transition subsystem to commercial application or prime system developer.

REFERENCES:

1. R. Longbrake, Avionics Acquisition, Trends and Future Approaches, AGARD Symposium, Paris, France Sept. 1987
2. M. J. Povinelli, A Planar Broad-Band Flared Microstrip Slot Antenna, IEEE Transactions on Antennas and Propogation, Vol. AP-35, No. 8 August 1987 pp 968-972
3. K. M. Pasala, E. M. Friel, Mutual Coupling Effects and Their Reduction in Wideband Direction of Arrival Estimation, IEEE Transactions on Aerospace and Electronic Systems, Vol. 30, No. 4 October 1994 pp 1116-1121

4. M. W. Hauser, Principles of Oversampling A/D Conversion, J. Audio Eng. Soc., Vol. 39, No.1/2, 1991 Jan./Feb. pp 3-26

AF98-165 TITLE: Unified Evidence Acrual for Data-fusion (UNEAD)

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop and demonstrate a new paradigm for accruing evidence in multisource, multi-target scenarios.

DESCRIPTION: The phenomenon of interest is detecting, localizing and identifying multiple maneuvering targets from corrupted evidence. The available evidence, which ranges from sensor reports to natural-language observations, is entirely stochastic, as is the behavior of the targets. Multi-source, multi-target data fusion is difficult partly because two fundamentally different types of observations must be fused: "precise" observations (e.g. sensor reports from a radar or electronic surveillance device) and "ambiguous" observations (e.g. natural-language reports, rules, and vague attributes). It is usually assumed that these two disparate observation types require very different fusion approaches. Fusion of precise observations is usually based on statistical filtering. That is, new observations are used to update current target estimates using some approximation of the Bayesian discrete-time nonlinear filtering equations (e.g. extended Kalman filters and multi-hypothesis algorithms). Ambiguous observations are usually fused using heuristic "expert systems" approaches (e.g., Dempster-Shafer theory, fuzzy logic, rule-based inference) seemingly unrelated to statistical filtering. This effort seeks to place multi-source, multi-target data fusion on a unified footing. The goal will be to demonstrate that precise and ambiguous information can be blended to produce a single quantitative interpretation of the evidence that is both rigorous and coherent. We seek a unified, theoretically defensible, and computationally tractable paradigm that will permit the simultaneous estimation of target numbers, identities and kinematics based on the systematic accrual of all types of evidence. Such a paradigm will help to illuminate situation assessment, which in turn leads to enhanced pilot situation awareness and better response planning. References 1 and 2 have developed probabilistic techniques that show progress towards these goals.

PHASE I: Produce a tool and a simulated experimental result adequate to show the potential for unified evidence accrual. An attractive demonstration problem might be a multisource scenario with a few separated bright targets in light clutter. A final technical report will document the work.

PHASE II: Further develop the chosen evidence accrual paradigm and evaluate it using appropriate metrics. Assumptions, capabilities and limitations of the paradigm will be identified, explored and reported. The Phase I problem will be expanded with a goal of demonstrating the paradigm for multiple interacting targets in significant clutter in scenarios that employ both simulated and real multi-source data. The final technical report will include the mathematical approach (the precise formalisms, associated models, and tractable computer algorithms), experimental results and their evaluation, and guidance for the engineer/practitioner wanting to apply the new paradigm.

PHASE III DUAL USE APPLICATIONS: The new paradigm addresses fundamental and pervasive issues that are critical to creating a viable data fusion infrastructure. Its importance is such that it will transition into any government program where search, track or identification are goals. In addition, applications in situation assessment, in threat assessment, and in resource allocation will benefit from using this paradigm. Additional application for evidence accrual abilities is found in a variety of industries and disciplines. Included are mining, medical diagnosis, rescue systems, drug interdiction, ocean exploration, force structure analysis and activity prediction, and air traffic control.

REFERENCES:
1. Ronald Mahler, "Nonadditive probability, finite-set statistics, and information fusion", Proceedings of 34th IEEE Conference on Decision and Control, New Orleans LA, December 1995, p. 1947-52, vol 2. 96-00026
2. Michael C. Stein and C. L. Winter, An Additive Theory of Bayesian Evidence Accrural, Los Alamos Report LA-UR-93-3336, 1993. Available through Reports Depository (505) 667-5013.
3. C. L. Winter and M. C. Stein, IES/BTI System Overview. Unclassified Proceedings of the 8th National symposium on Sensor Fusion, Dallas, Texas, 15-17 March 1995.

AF98-166 TITLE: Very High Speed Integrated Circuit Hardware Description Language (Vhdl) Models for Network Open System Architectures

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a set of VHDL (ANSI/IEEE 1076 standard) models to support standard network open system architectures in new and replacement avionics.

DESCRIPTION: In order to reduce the cost of sustaining its warfighting capabilities, the Air Force is continually driving toward the use of commercial standards, for its electronic equipment. Network Open System Architecture standards such as the industry standard Asynchronous Transfer Mode (ATM) and Real-Time Scaleable Coherent Interconnect (SCI-RT), will be used more and more to support integrated avionics systems architectures. A set of VHDL models is needed to support top-down design and virtual prototyping of systems with these industry standard network protocols. The set must include: a) performance models that indicate system level timing details for selection and implementation trade-offs; b) functional models which describe the function without timing for virtual prototyping; c) interface models which describe the port structure, the functional, and the timing details for virtual prototyping and interface design; and, d) a synthesizable register-transfer level model which would be used to design a custom interface circuit. Test vectors would be developed and marketed that support all of the models.

PHASE I: The preliminary design of the models will be performed and specified.

PHASE II: The models and test vectors will be constructed and verified. Reference manuals and user guides will be developed.

PHASE III DUAL USE APPLICATIONS: All models developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems. Similar network architectures are widely utilized in commercial computing systems.

REFERENCE: ANSI/IEEE 1076 VHSIC hardware description language (vhdl) reference manual ANSI/IEEE

AF98-167 Title: Turbo Codes for Data Links

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Implement an appropriate Very High Speed Integrated Circuit Hardware Description Language (VHDL) Turbo Code design for use in digital data links.

DESCRIPTION: Many of the new and evolving weapon systems, such as Unmanned Aerial Vehicles (UAVs), require highly reliable data communication links to transfer large amounts of digital data. The data can include extremely high resolution imagery, along with other high value data, which could use the Asynchronous Transmission Mode (ATM) format. This type of implementation is extremely sensitive to errors generated in the communication link and, therefore, the communication system must be designed with high link margins. The required high link margins impact the size, weight and prime power consumption (SWAP), and there can be significant cost impacts, ranging from the cost of the communications system to the cost of operating the system long term. Theoretically, new Turbo Codes offer significant improvement over the existing data link code implementations, and should result in reduced SWAP and system life cycle cost.

PHASE I: Research the various Turbo Code designs and architectures, evaluate the tradeoffs involved with the various types of codes and the impacts on performance of various data link applications. The specific selection would be evaluated through simulation of critical performance requirements.

PHASE II: The selected Turbo Code design would be implemented in VHDL. 0.35u complementary metal oxide (CMOS) would be minimum with 0.25u CMOS being a highly desirable goal. Phase II would include a prototype implementation.

PHASE III DUAL USE APPLICATIONS: Significant improvements in communication link performance can result in lower cost, whether in a military or commercial application. The final chip implementation would be for use in data links requiring very low bit-error-rate performance.

REFERENCES:

1. Divsalar, D.; Pollara, F. On the Design of Turbo Codes Jet Propulsion Laboratories, Pasadena CA, The Telecommunications and Data Acquisition Progress Report 42-123, p.99-120, 1995. N96-16690.

2. Viterbi, Andrew Approaching the Shannon Limit: theorist's dream and practitioner's challenge Proceedings of the 1996 2nd European Workshop on Mobile/Personal Satcoms, Rome, Italy, 1996 Mobile and Personal Satellite Communications International Conference on Millimeter Wave and Far Infrared Sciences and Technology Proceedings, ICMWFST '96. IEEE, p. 1-11.

AF98-168 Title: Innovative Electro-optic Device Technology for Military Unique Devices

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop electro-optic device technologies to enhance electronic functions and/or sensor capabilities.

DESCRIPTION: Innovative eletro-optical device technology should be developed. These devices need to support low cost per function sensing approaches, including RF sensors, EO sensors, and digital technolgy required on board aerospace systems to support sensing or to fuse data from multiple sensors. Electro-optical switching and distribution systems for multifunction EO systems and for true time delay RF phase arrays systems should be considered. Larger focal planes for full situational awareness and multispectral focal planes should be considered.

PHASE I: Design new EO devices for the above applications and assess feasibility of developing them, as well as, the payoff in terms of low cost per function sensing.

PHASE II: Develop innovative new EO devices designed in Phase I.

PHASE III DUAL USE APPLICATIONS: Commercial applications that will benefit from innovative electro-optic device technological advancements include optical sensors for environmental assessment and/or surveillance, high speed electronics for computers and/or communications systems, and miniaturization components and /or diagnose capability for the medical and/or industry.

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AF98-169 TITLE: Solid State Laser Projector (SSLP)

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop SSLP for aerospace panoramic/immersive human system interfaces and sensor development.

DESCRIPTION: There is a need for a large area display technology that can project onto curved surfaces without distortion, yet provide 2X greater luminance, 3X sharper pixel-to-pixel modulation, 2X better color fidelity, 10X less volume and power than any projection technology presently available. Laser projection systems can meet the imaging performance requirements. However, laser projection systems that have been used to date have been gas-dye systems requiring too much volume, power, cooling, and operational maintenance than is compatible with command center applications, let alone other DoD applications requiring similar supportability and performance problems. Solid State lasers and the associated modulation and scanning technologies have advanced to the point that a properly constructed, innovative project might build a prototype solid state laser projection display system which would be a commercial success for civil as well as military products.

PHASE I: Research will result in a manufacturable design which takes into account reliability and maintainability issues for environments typical of airborne crewstations and ground-based simulators.

PHASE II: The design from Phase I will result in a prototype SSLP to be delivered for use in a wide variety of applications involving synthetic vision and panoramic/immersive interfaces. The contractor is expected to participate in receiving the feedback from these evaluations to refine their design of a production version of the SSLP.

PHASE III DUAL USE APPLICATIONS: Displays are the quintessential dual-use technology. Military applications of SSLP include the Air Force and other DoD battle labs, C4I crewstations, command centers, unmanned aircraft cockpits, complete autovisual environments and large area panoramic/immersive cockpits for future space/aircraft. Commercial applications may include engineering design systems, professional presentation systems, conference rooms and auditorium systems, training, education, entertainment, advertising, and scene generators for sensor development.

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1. Color Panoramic Laser Projector, Department of the Navy, Washington DC, patent, US3992718.
2. F.C. Gibeau and K.K. McKinney, "Compact Solid State Laser Projector," in Cockpit Displays IV: Flat Panel Displays in Defense Applications, Darrel G. Hopper, Editor, Proc. SPIE 3057, Paper 28 (1997).
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AF98-170 TITLE: True 3-d Tactical Threat and Command/control Display

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop true 3-D display for application of pre-computed hologram symbol fonts in airspace warning/control.

DESCRIPTION: There is a need for a true 3-D display system with multiperspective horizontal parallax which does not require anything on the user's head. Applications include: (a) a tactical threat warning display for fighter pilots with a 3-D wire sphere which projects into the cockpit space only when a threat is present and (b) a command and control function in which the operator must visualize objects in a three-dimensional volume. Computational holgraphy has permitted the pre-computation of horizontal parallax only computer generated true3-D symbol sets (fonts) comprising simple "wire" depictions of characters and arbitraily shaped objects. A hardware system is needed to project two or more colors of this font. No such system exists which is viable for commercialization. This project is to develop a commercially viable prototype to display such precomputed 3-D fonts. Various spatial light modulator technologies that may be appliable include acousto-optic cells, digital micromirror devices, diffraction-control silicon light machines, and active matrix liquid crystal displays.

PHASE I: The program is expected to result in the design of a prototype unit which will be fabricated and demonstrated in Phase II. The Phase I design is expected to incorporate a consideration of manufacturability, reliability, and maintainability.

PHASE II: Prototype will be delivered for evaluation via part-task pilot-in-the-loop inhouse studies to be accomplished by a government team comprising personnel drawn from the diverse disciplines of avionics, crew station integration concepts, and human factors, with the contractor participating in receiving feedback from the team to ascertain potential refinements to the original design.

PHASE III DUAL USE APPLICATIONS: Displays are the quintessential dual-use technology. Military applications of true 3-D include mounting in the bezel area of a display for tactical jet cockpit threat warning, airborne command and control, air traffic control, battle laboratories, and command centers. Commercial applications may include engineering design systems, professional presentation systems, conference rooms and auditorium systems, training, education, entertainment, advertising, and air traffic control.

REFERENCES:
1. E.A. Sholler, F.M. Meyer, M. Lucente, and D.G. Hopper, "True 3D for Avionics Cockpit and Mission Crewstations," in Cockpit Displays IV: Flat Panel Display in Defense Applications," Darrel G. Hopper, Editor, Proc. SPIE 3057, Paper 4 (1997).
2. M. Burney, "Converting 3D Into Volumetric Images," ibid, Paper 41 (1997).
3. P. Soltan, M. Lasher, W. Dahlke, N. Acantilado, and M. McDonald, "Laser-Projected 3D Volumetric Displays," ibid, Paper 42 (1997).

AF98-171 TITLE: New False Alarm Reduction Techniques for Infrared Missile Warning Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop range/range rate dependent rejection techniques that reduce false alarms of infrared warning systems.

DESCRIPTION: Spatial, spectral, temporal, and angle tracking techniques have been the classic methods for rejecting false targets in airborne infrared missile warning systems. With these airborne systems, amplitude growth has not been a reliable method of determining if a detected source is an approaching missile. However, there is the possibility that some characteristic(s) of a real missile may define it as being an approaching threat and as being uniquely different from a source that is stationary (relative to the ground) and/or is not an approaching missile. Since the platform that is carrying the infrared warning sensor is continually approaching the ground in the forward sector, as seen by the sensor, the technique must be able to determine the difference between

a source that the aircraft is flying towards vs. a missile that is approaching at a much faster rate than the ground source. A technique that uses some characteristic(s) of a missile that changes with range and is not solely dependent on amplitude could be used to further reduce the false alarm rate of threat warning systems that presently use classical clutter rejection techniques. These techniques should not add greatly to the complexity and cost of the sensor.

PHASE I: Conceptual design, analysis, and proof-of-concept experiments for false alarm rejection.

PHASE II: Design, fabrication, and demonstration of breadboard system.

PHASE III DUAL USE APPLICATIONS: The technology developed under this program will have application to systems installed on civilian aircraft for use against terrorist activities.

REFERENCE: Chen, Steve, et al., Detection In Clutter Enhancement, Dec 1995, WL-TR-96-1007 (ADB 214 558).

AF98-172 TITLE: Enabling Criteria Development for Unitized Composite Structures

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop design criteria for adhesively bonded, textile reinforced, and through thickness reinforced composite structures.

DESCRIPTION: The Air Force is currently emphasizing the development of unitized composite structures to simultaneously reduce the cost and weight of air vehicles. Adhesive bonding, textile fiber reinforcements, and through the thickness fiber (Z-fiber) reinforcement are three enabling technologies to allow low cost, efficient, and reliable designs for unitized structure joints, intersections, and interfaces. The use and performance of these technologies is currently limited by existing design and failure criteria. Current composite structure design and failure criteria does not allow for flaws and processing variability. Recent concept development work, however, has shown that textile and Z-fiber reinforced structures can be damage tolerant and have the ability to carry significant load and strain after a delamination or flaw has developed. Adhesively bonded structure has been shown to be tolerant of processing variations and service environments. The goal of this effort is to characterize the effects of defects, processing variations, and service environment on these enabling technologies and develop new robust design and failure criteria and failure prediction capability.

PHASE I: Demonstrate the feasibility of damage and process tolerant design and failure criteria and failure prediction capability for adhesively bonded, textile reinforced, or Z-fiber reinforced structure, through analysis and sub-element test demonstrations.

PHASE II: Develop the Phase I design and failure criteria and failure prediction capability and apply to the design of a full size structural component and demonstrate and assess the payoffs through fabrication and test.

PHASE III DUAL USE APPLICATIONS: This technology will enable a more efficient and expanded use of composites for safety critical components in commercial automobiles, trucks, buses, and trains leading to significant cost savings which is crucial for commercial products. A great market potential also exists for application to lightweight, long life, corrosion free composite building components such as columns, beams, and girders for public bridges and buildings.

REFERENCE: WL-TR-93-8009, "Design and Manufacturing of Low Cost Composites, Bonded Wing, " November 1992. (ADB 173 453 Statement D)

AF98-173 TITLE: Hybrid Convection/Radiation Heat Rejection Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop technologies to reject air vehicle heat loads through adaptive convection and radiation.

DESCRIPTION: Thermal management onboard air vehicles has always been a challenge. Standard approaches require substantial amounts of heavy equipment and consume a fair amount of power, both of which affect total air platform size and range. With the continued growth in the density of electronics mounted in the vehicles, combined with the operational need to control the infra-red (IR) signature of ground visible surfaces, this problem has taken on a new dimension: the design limit is becoming the ability to reject heat to the environment. This will be especially critical for the next generation of high altitude, long endurance uninhabited air vehicles (UAV). Total heat loads for this class of vehicle are expected to be in the 15 to 50 kW range. Under high altitude conditions air densities are low, thus limiting the convective heat transfer rate. These same conditions, however, allow radiation to

a very low black body temperature sink. Coatings and surface treatments exist which allow the emissivity of a surface to vary as a function of radiation frequency, enabling rejection of solar energy while radiating strongly at a longer wavelengths. By combining both convection and radiation into a single platform, the thermal management system can adapt to the sink available at various points throughout the mission profile (e.g., use convection where air densities are high, switching to radiation at lower densities when re-radiation by the atmosphere is less). The system may adapt passively, by allowing the relative efficiency of the two processes to determine the mix, or actively in response to some tactical objective. This technology will be critical for hybrid air/space vehicles.

PHASE I: Analysis and conceptual design work will be performed to evaluate the feasibility of developing a hybrid convection/radiation heat rejection device. This will include analysis of the relative convective and radiative heat sinks available at altitudes of interest to UAV's (0 to 60,000 feet). For radiation, the optimal wavelength (e.g., black body source temperature) for heat rejection as a function of altitude should be determined. The analysis and conceptual design will also address the compatibility of developed concepts with the aircraft and its subsystems. The design will show sufficient technology maturity for orderly development into aircraft systems with compatible environmental factors. The Phase I work will produce a competent technical report and plans for experimental development in a proposed Phase II effort.

PHASE II: This phase continues the necessary analytical work and provides experimental verification of predicted heat rejection capacities for the adaptive convection/radiation device. Laboratory simulation of typical operating conditions will evaluate performance at various altitudes and heat loads. Any environmental restrictions will be assessed. Benefits to be gained from the use of the hybrid system will be quantitatively established for different potential applications to prepare for possible commercial development of the system. A comprehensive technical report will document all of the work conducted, a final optimized design will be completed, and a demonstration device will be fabricated.

PHASE III DUAL USE APPLICATIONS: Dual-use commercialization will be considered in all phases of this effort. Potential commercial applications include in-flight cooling on the High Speed Civil Transport (HSCT), large facility cooling (e.g., air conditioning), and integrated boost-phase cooling for commercial satellite launches.

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2. "Development of a Self Contained Heat Rejection Module, Phase 2 and 3" (Final Report), Fleming, M. L., Vought Corp., Dallas, Tex. Systems Div. Report No.: NASA-CR-151109; T211-RP-032, 17 Aug 76
NTIS Accession Number: N77-12068/1

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Volume 2. (A77-24201 09-44) New York, Academic Press, Inc.; Washington, D.C., Hemisphere Publishing Corp., 1976, p. 713-726.

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AF98-174 TITLE: Aeromechanics for Future Aircraft Technology Enhancement

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop aeromechanics technology for affordable 21st century aircraft with advanced maneuverability, increased range, and survivability.

DESCRIPTION: The USAF has a vital interest in the development of manned and unmanned aircraft with significant advancement in flight performance and mission effectiveness. These advanced air vehicles will rely on innovation in aeromechanics technology to achieve new levels of speed, maneuverability, range, payload capability, low life cycle cost and rapid design development. Advancements are needed in the following areas: (a) accurate engineering design methods for determining aerodynamic characteristics and flight performance of unconventional aircraft, (b) accurate, efficient computational fluid dynamics methods to describe both steady and unsteady airflow about air vehicles, (c) flow control devices which can be used to reduce drag or improve inlet or nozzle performance, (d) methods to improve the accuracy and reduce the cost of wind tunnel experiments through more accurate measurements and extrapolation of subscale results to flight, (e) efficient integration of inlets and nozzles, and (f) innovative

aircraft configurations which produce advanced performance capabilities.

PHASE I: Define the proposed concept, outline the basic principles, and establish the method of solution. Present an example of the advanced performance which will result from the technology. Determine the risk and extent of improvement over existing methods.

PHASE II: Build a prototype application of the equipment or software. Demonstrate the advanced technology under actual engineering conditions.

PHASE III DUAL USE APPLICATIONS: Improved performance and safety of commercial and private aircraft will be realized with the application of this technology. New areas of commercial growth will result from aircraft design tools which allow fast and accurate development of air vehicles to respond to aircraft needs throughout the world. Examples are devices which allow aircraft to operate from remote fields, carry large payloads at low cost, and are economical to produce and operate. New aerodynamic analysis tools will improve education methods and allow industry to produce with lower initial investment. Advanced experimental methods are applicable to more efficient ground transportation systems.

REFERENCES:
1. "Requirements for Effective Use of CFD in Aerospace Design," Pradeep Raj; NASA Conference Proceedings #3291, pp 15-28, NASA Lewis Research Center, Cleveland, Ohio, May 1995. (95N28725)
2. "Propulsion Integration Issues for 21st Century Fighter Aircraft," Marvin Gridley and Steven Walker, Paper #42 in Proceedings of AGARD Propulsion Energetics Panel, Seattle, Washington, Sep 1995. (96N36606)
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AF98-175 TITLE: Flight Control Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop flight control technology to contribute to National Fixed Wing Vehicle (FWV) Program goal set.

DESCRIPTION: The following are advanced flight control technologies that contribute to this National FWV goal set. The research sought here contributes to reduced production cost; reduced operations & support cost; reduced engineering, manufacturing & development cost; increased cruise Lift/Drag; reduced airframe weight; and increased agility/maneuverability. The Air Force is interested in the development of one or more of the following advanced flight control technologies for future fixed wing air vehicles: a) high response electric actuators which have minimal or no rotating inertia for fighter/attack aircraft control surfaces, b) active aeroelastic control of combat aircraft which use wing twist as part (or all) of the control moment generation in the lateral axis, c) strategies and automation algorithms for robust uninhabited combat air vehicle (UCAV) multi-ship flight path management blending the critical issues of cost, flight safety, authority level, operator workload, and control integrity, d) aerodynamic simulation models for multiple UCAVs flying in close coupled formation flight and control algorithms to minimize drag, e) modeling and control of extreme maneuvers based on unsteady aerodynamics, and f) UCAV flying qualities guidelines and criteria with focus on remote operator controller characteristics and quantitative workload assessment methods and equipment.

PHASE I: Expectations for this phase include determining feasibility, preliminary concept identification, and requirements definition. Some specific examples are electric actuation design trades, aeroelastic wing control algorithm description, and candidate control algorithms for UCAV formation flight.

PHASE II: Expectations include hardware build-up, design verification, performance evaluation and simulation. Phase II shall also address the issues of form, fit, and function or software sizing of the mechanization/implementation. Examples include demonstration of the device in a realistic environment, algorithm evaluation in a full envelope flight control system design, and simulation of automated UCAV formation flight.

PHASE III DUAL USE APPLICATIONS: All of the items are generally applicable to both the civilian and military sectors. Additional commercial potential may be in the area of robotics, process control, or mining operations. The technology developed will provide for greater integration at the system level, more affordable configurations, more efficient and supportable flight control architectures, and the ability to operate air vehicles safely and effectively in an internetted multi-ship environment.

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4. J.D. Wolfe, D.F. Chichka and J.L. Speyer, "Decentralized Controllers for Unmanned Aerial Vehicle Formation Flight," AIAA 96-3833, AIAA Guidance, Navigation and Control Conference, Jul 1996.

AF98-176 TITLE: Aging Aircraft Support/Sustainment Reduction

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop methodologies for assessing and mitigating the effects of aging aircraft.

DESCRIPTION: The combination of aircraft operating under loads more severe than anticipated and/or for longer service lives than originally intended, coupled with limited replacements due to fiscal constraints, has led to an increased focus on technologies aimed at reducing the support/sustainment burden of these aging aircraft. The problems facing these aircraft include, but are not limited to, corrosion, fatigue cracking (including multi-site/multi-element damage), stress-corrosion cracking, buffeting and sonic fatigue. Research efforts should involve generating analytical methodologies to assess the impact of the damage on the airframe and/or developing techniques to mitigate these problems either proactively or as they occur.

PHASE I: Develop design/analysis tools and/or mitigation techniques.

PHASE II: Design/analysis tools and techniques developed in Phase I will be validated by experimentation.

PHASE III DUAL USE APPLICATIONS: Many problems plaguing military aircraft are evident in the commercial fleet as well and close coordination between the USAF and FAA in the area of aging aircraft research has yielded, and will continue to yield, products of mutual benefit.

REFERENCE: Mar, J. W. "Structural Integrity of Aging Airplanes: A Perspective," Structural Integrity of Aging Airplanes, S. N. Atluri, S. G. Sampath, P. Tong, Editors, Springer-Verlag, Berlin, Heidelberg, 1991.

AF98-177 TITLE: Automated Bird Detection and Warning System for Airports

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop an airport bird detection/warning system to reduce the risks of severe aircraft birdstrikes.

DESCRIPTION: About 50% of military birdstrikes and 75% of commercial birdstrikes occur on or near airports. At the present time, airport bird control programs rely upon people to notice birds in hazard areas. Those people pass the word, and personnel tasked with assessing the situation and/or driving the birds away are notified. They respond and take appropriate actions. This generic approach means there is a significant time between the initial creation of the hazardous bird condition and action to reduce the birdstrike risk. Any breakdown in communication greatly worsens the situation. A practical, automated bird detection and warning system for airports could greatly reduce birdstrike risks. Infrared (IR) detectors are capable of detecting birds in flight or on the ground, while radars can detect birds in flight many miles away. Computer software for recognizing and tracking targets has been in wide use for decades, but not for tracking birds. Software that provides notifications or sounds alarms when specified conditions are detected is also state-of-the-art, but not for use with birds. A system needs to be developed that is effective, affordable, practical, and adaptable for use on a wide variety of military and civilian airports. The system must not interfere with landing systems or other electronic equipment, should not be sabotaged by emissions from such equipment, and must comply with various safety, FAA, and other requirements such as separation distances of structures from runways.

PHASE I: Results should include identifying operational requirements and limitations the system must handle, and designing one or more candidate systems.

PHASE II: Results would include constructing, testing, and conducting an operational evaluation on a prototype system.

PHASE III DUAL USE APPLICATIONS: Applications would include operational systems for military and civilian airports world-wide. Every large or medium sized commercial airport in the world would be a potential customer. Much less sophisticated systems could be adapted for use by farmers as part of a berry crop protection program, and a "people detector" version could become a capable security system for warehouses and large outdoor storage areas.

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4. NTIS Accession # AD-780 597, The Observation of Birds with Weather and Airport Surveillance Radars, AFWL-TR-74-57.
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AF98-178 TITLE: Active Flow Control

CATEGORY: BASIC RESEARCH; Air Vehicles/Space Vehicles

OBJECTIVE: Develop a device to improve the performance of weapon systems through the application of active flow control.

DESCRIPTION: The current boom in the development of Microfabricated Electromechanical Systems (MEMS) devices has sparked a renewed interest in all aspects of active flow control. These typically small, low power requirement devices, allow for localized control of skin friction, heat transfer rate, state of turbulence, and surface shape. Potential applications include reduction of aircraft drag (improved range) through active boundary layer control, wing shaping for improved performance at off-design conditions, inlet shaping for optimal pressure recovery (while maintaining good survivability characteristics), nozzle shaping for area control without mechanical devices, nozzle jet vectoring without heavy moving flaps, nozzle jet mixing for reduction of plume temperature, control of flow noise, as well as control of the damaging acoustic environment and store separation characteristics within weapons bays. Areas of interest include: integration of existing devices into aircraft systems, development of rapid flow control design methods allowing designers to utilize the technologies in tradeoff studies, development of control systems (neural net or conventional) for optimization of the device performance, experimental validation of a potential device, development of a new device, or simulation of the device to elucidate relevant flow physics.

PHASE I: Experimental demonstration of active control device, simulation of single isolated device flow control characteristics, simulation of a flow control strategy, tradeoff study showing optimal sensor/actuator locations.

PHASE II: Demonstration of active device under simulated flight conditions, simulation of bank of devices, implementation of breadboard mockup of control system with sensors/actuators, tradeoff study showing impact of installed devices on mission performance.

PHASE III DUAL USE APPLICATIONS: Virtually every commercial market which deals with some aspect of flow control stands to benefit from this technology. High efficiency commercial aircraft, quiet aircraft, more efficient aircraft engines, electronics cooling, enhanced turbine cooling, enhanced fans, compressors, quiet car interiors, are just some of the more obvious examples of the potential commercial applications. The cometitive posture of the United States with respect to designing, manufacturing, and selling high energy-efficient devices is greatly enhanced by this technology. Increased emphasis in the commercial market on quiet products (planes, dishwashers, automobile cabins, hairdryers), and on higher density electronics (more heat generated in a smaller package) means that active control of aerothermal and aeroacoustic environments will play a major role in new product development.

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AF98-179 TITLE: Simplified Manual Flight Control

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop method for low operator workload manual flight control of fixed wing uninhabited air vehicles.

DESCRIPTION: This effort supports a key element of the Air Force Material Command's Uninhabited Air Vehicle (UAV) Emphasis Area, as well as technology requirements identified in the Air Force Scientific Advisory Board's New World Vistas studies. A remote operator of a UAV will, at times, need to disconnect the auto-pilot and manually direct the vehicle to achieve mission objectives. The task of manually flying fixed wing UAVs must be made much simpler and easier for remote operators, to require much less training, thereby not requiring UAV operators to be expensively trained rated pilots. Current flight control technology requires a great deal of operator skill and attention to manipulate engine controls, flight controls (in three axes), and supplemental control devices (flaps, speed brakes, spoilers, etc.) while monitoring flight performance and navigation. This effort will explore aerodynamic, propulsion, and control system technology means to simplify the manual flight control task. As an example of a simple low workload concept; a UAV could be designed such that, rather than manipulating throttle and flight control surface position, a remote operator would manually command the turn rate and vertical speed (or gradient) using a yoke or joy stick, with the system controlling the power and flight controls to maintain optimum angle of attack (or the pilot's set speed). The operator would never have direct control of power or attitude, and would never be able to over-bank, stall, or spin. The challenge is to select the appropriate mix of technology concepts to achieve the goal affordably, which is important for application to military UAVs. This simplified manual control approach could also be easily applied to civilian commercial and general aviation aircraft where the control station functions are in place on the air vehicle rather than at a remote location.

PHASE I: Explore likely technology options. Select a target air vehicle for affordable demonstration. Design the flight control system and operator interface. Develop flight control algorithms.

PHASE II: Develop flight control hardware and software. Modify demonstrator air vehicle. Flight demonstrate the concept using remotely piloted aircraft or a surrogate piloted aircraft, where the on-board pilot serves as a safety backup for the remote operator.

PHASE III DUAL-USE APPLICATION: Military UAVs and general aviation aircraft production. This technology would enable military UAVs that do not require rated pilots to operate. For civil applications, this technology would enable certification and production of a new generation of general aviation aircraft that are simpler, safer, and require less training.

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AF98-180 TITLE: Adaptive Wing Structures for Enhanced Aircraft Maneuver

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop innovative wing structures that exploit structural flexibility to improve maneuver performance.

DESCRIPTION: Develops innovative structural concepts that exploit wing flexibility to enhance maneuver of inhabited or uninhabited aircraft. The employment of these structural concepts will enable elimination or reduction in the number and size of conventional, discrete control surfaces and will impact flight vehicle weight, drag, and signature. While a more flexible wing has the ability to be shaped and used as a force multiplier for various flight conditions, it is also more susceptible to dynamic instabilities. Careful consideration of these dynamic challenges must be made in the design and development of this technology.

PHASE I: Perform a feasibility study (primarily analytical) of the submitted concept considering either a current operational vehicle or a new vehicle design. This study will focus on estimating the payoff in terms of vehicle performance and weight impact as well as looking at preliminary integration issues and dynamic instabilities.

PHASE II: Perform ground or wind tunnel tests (or both) to demonstrate and validate the concept developed in Phase I.

PHASE III DUAL USE APPLICATIONS: Adaptive structures can be used to design lighter weight commercial and military aircraft. This technology also increases the lift over drag ratio. Performance of both small and large aircraft can benefit from this technology.

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2. Hustedde, Cindy L., Reich, Gregory W., Hopkins, Mark A., and Griffin, Kenneth E., "An Investigation of the Aeroelastic Tailoring for Smart Structures Concept," 37th AIAA Structures, Structural Dynamics and Materials Conference, Salt Lake City, Utah, April 1996.
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5. Perry, B., III, Cole, S. R., and Miller, G. D., "A Summary of an Active Flexible Wing (AFW) Program," Journal of Aircraft, Volume 32, January-February, 1995. p.10-

AF98-181 TITLE: Advanced Fly-By-Light Control of Electric Flight Control Actuation

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Investigate the application of a photonic signal interface to accurately control electric actuation devices

DESCRIPTION: This topic ties in two important advanced flight control technologies; fiber optic control signaling [Fly-By-Light (FBL) and electric actuation [Power-By-Wire (PBW). Both technologies are key to achieving the flight control technology effort objectives of reduced control system weight and reduced development cost and time for the National Fixed Wing Vehicle (FWV) Technology Program. The state-of-the-art for FBL/PBW is a system that is integrated by an optical data bus, which does not take full advantage of the benefits of photonic technologies. This approach depends upon a weighty Bus Interface Unit, which requires conditioned low level power, as well as, some form of processor. Whereas optical signals have a high tolerance to electro-magnetic interference (EMI), most electro-optic interfaces have high susceptibility to EMI, due to low signal power and high bandwidth. Placing a fragile interface in high EMI, harsh physical environment, such as near an electric actuator, requires circuit hardening in conjunction with robust packaging. A true FBL/PBW system will require a simple, light weight interface where an optical signal provides the control signal to the power electronics of the electrical actuator and the feedback from the actuator and motor controller. The technology gap lies in the immaturity of robust, fully optical effector interfaces (e.g. optically controlled high power switches) and to a lesser degree optical sensors (e.g. current, voltage, pressure, linear position, rotary position, etc.). For electric actuation, fiber optic applications range from accurate control of high electric power switches (i.e. MCT's, and IBGT's) to precision measure of motor and output device position for feedback. The emphasis should be on a total optical actuator interface solution. The ultimate goal is two lanes between the Flight Control Computer (FCC), the actuator and the motor controller; one fiber optic control link and one 270VDC power source.

PHASE I: Assess the photonics and power device technology areas and develop a design for the fly-by-light control of an electric flight control actuator. Performance verification by modeling and simulation is desirable.

PHASE II: Include hardware build-up, design verification and performance evaluation. Phase II shall also address the issues of form, fit, and function of photonic control of an electric flight control actuator. A demonstration of photonic actuator control in a realistic environment would be the culmination of Phase II.

PHASE III DUAL USE APPLICATIONS: Advanced Fly-By-Light Control of Electric Actuation has application not only to military fighter and transport aircraft, but to commercial airline and business jet flight control and avionics as well. Wavelength Division Multiplexing (WDM), photonic switching and other fiber optic technologies developed for use in the telecommunications industry are examples of commercial technologies (COTS) potentially applicable to this topic. Potential non-aerospace applications include the automotive industry (drive-by-light), robotics, and factory automation.

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AF98-182 TITLE: Aerodynamic Drag Reduction

CATEGORY: BASIC RESEARCH; Air Vehicles/Space Vehicles

OBJECTIVE: Develop and demonstrate aerodynamic drag reduction concepts/techniques that contribute significantly to achieving the Fixed Wing Vehicle, Technology Development Approach Goals for increased air vehicle cruise lift/drag.

DESCRIPTION: Aircraft range is a direct function of cruise lift/drag as specified by the Breguet range equation. Improvement of aircraft cruise lift/drag enhances range efficiency directly affecting aircraft size, operating cost and acquisition cost. Increasing cruise L/D is primarily focused on drag reduction, since aircraft lift is tied directly to mission requirements and is not easily altered without impacting critical mission parameters. Modern aircraft design practices tend to minimize the profile, induced and compressibility drag components by sizing the aircraft to accomplish specific missions. The friction, interference and to some extent the wave drag component are not as easily controlled in the design process, however, these drag components can be markedly reduced by the practical application of innovative drag reduction techniques. Shock control with passive porosity, thermal boundary layer control and micro-electromechanical systems (MEMS) for active/passive control of boundary sub-layer flows are just a few of the drag reduction ideas under current investigation. The next big stride in aerodynamic drag reduction may come from one of these areas or it may emerge from research in other fields, such as, electromagnetics or magneto-hydrodynamics (MHD). The opportunity exists for breakthrough drag reduction developments which have equal value in both the military and civil air vehicle development field.

PHASE I: Experimental or substantiated analytical feasibility demonstration of a drag reduction concept with significant aircraft cruise lift/drag improvement potential.

PHASE II: Drag reduction concept demonstration under simulated flight conditions. The work effort must include an energy balance assessment if an active system is utilized.

PHASE III DUAL USE APPLICATIONS: The entire civil aircraft industry is interested in efficient, cost-effective, drag reduction technology.

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2. Bushnell, D.M., and Hefner, J.N., "Viscous Drag Reduction in Boundary Layers," Progress in Astronautics and Aeronautics, Vol. 123, 1990, A 91-12689 to A 91- 12699.

AF98-183 TITLE: Flight Simulation Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Develop innovative flight simulation technologies which support advanced fixed-wing vehicle research.

DESCRIPTION: The Air Force is seeking innovative flight simulation technologies to support research and development of advanced aircraft and aircraft subsystems. Areas of interest include any technology, hardware, or software program/architecture that shows potential for advancement of the state-of-the-art in engineering research flight simulation. Potential areas of research include: a) improvements to real-time simulation network performance, b) improvements in application of optimization theory, data representation or tool integration to support constructive simulations, c) new methods to upgrade constructive models for compatibility with virtual simulation, d) promising concepts for synthetic battlespace which integrate constructive and virtual simulation with live assets, e) techniques to quickly transition aircraft simulations from the prototype stage to a real-time implementation for pilot evaluation, f) improved simulator verification and validation testing techniques, g) innovative approaches for use of High Definition Television (HDTV) displays in a flight simulator cockpit, h) novel application of commercial off-the-shelf equipment to reduce the life-cycle-cost of research simulators.

PHASE I: Define the proposed concept, investigate alternatives, and predict performance of the proposed design. Demonstrations of high-risk portions of the design are encouraged, but not required.

PHASE II: Implement, demonstrate, and test the Phase I design. The design, including results of performance tests, shall be documented in a final report.

PHASE III DUAL USE APPLICATIONS: Improvements in flight simulation technology have application to flight simulators used by the airline industry and to satisfy FAA training requirements. Flight simulation technologies can also be applied to the expanding fields of virtual reality, medicine, and manufacturing.

REFERENCES:
1. Full Mission Simulation for Research and Development of air Combat flight and Attack Management System; Goddard & Zeh; AGARD-CP-513; 1991. ADP 006 863
2. Dynamic Latency Measurement Using the Simulator Network Analysis Project (SNAP); Bryant et al. IITSEC; 1994.
3. Engineering Flight Simulation - Capabilities and Future Direction for Wright Laboratory, 1993 Aircraft Flight Safety International Conference, Gum, 1993.

AF98-184 TITLE: Innovative Damping Concepts for Extreme Environments

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop damping concepts for structures subjected to exhaust wash, centrifugal loading, and other extreme environments.

DESCRIPTION: Although there are a number of relatively mature technologies associated with damping non-rotating structural components at temperatures below 500 degrees Fahrenheit, there is a critical need for damping concepts appropriate for static structure and rotating component applications that are subjected to high temperature vibratory loads and other extreme environments. Existing polymeric viscoelastic damping materials are only effective over a narrow temperature range, and become susceptible to creep or material decomposition when exposed to elevated temperatures and/or when subjected to large steady state loads. For extreme environments, damping concepts using polymeric materials must include some sort of innovative scheme to address these problems. Alternative approaches to the use of polymeric viscoelastic materials may be identified for the damping concept, and damping treatments that are relatively insensitive to temperature would be very useful in many applications. An analytical model that can be used in the design of the damping treatment is required so that the damping design will not be based on an empirical "trial and error" approach. The damping treatments may be designed for specific extreme environment applications of interest to the Air Force, including engine nozzles, hypersonic vehicle structures or exhaust washed structures, and rotating components within air vehicle engines. One application of special interest is the damping of aircraft turbine engine blades, which supports research to reduce the effects of high cycle fatigue (HCF) in aircraft engines.

PHASE I: Demonstrate the feasibility of the damping concept, including its compatibility with elevated temperatures and/or sustained steady state loads. If the damping treatment is intended for a specific Air Force application, the feasibility study should include analytical studies of the concept that predict the level of damping to be seen in the component and an evaluation of the effectiveness of the damping treatment in the system environment.

PHASE II: The damping treatment must be fabricated and then tested to demonstrate its effectiveness in the application considered. The testing must effectively demonstrate the damper's durability in the environment for which it is designed. The Phase II program must also demonstrate that the treatment can provide effective damping without adding excessive weight, cost, or maintenance requirements.

PHASE III DUAL USE APPLICATIONS: There are several commercial markets for damping technologies that are capable of withstanding elevated temperatures and large steady state loading, including vibration isolation devices for heavy machinery. Damping concepts can also be used in the commercial aircraft and automotive industries to reduce undesirable vibration in vehicular structures and engines. Added damping reduces resonant response, which reduces requirements for maintenance and enables the development of lighter weight, higher performance turbine engines. Large turbines used in the power generation industry, which have realized benefits from lower temperature damping concepts could also benefit from high temperature damping concepts.

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2. Kumar, B. & M,L. Drake. "Constrained Layer Damping with Vitreous Enamel", Journal of Sound And Vibration Vol. 93(3), 389-395.
3. Kluesner, M.F. and D.R. Oeth. "Results of Recent Research on Damped Fan Blades." The American Society of Mechanical Engineers (ASME) paper 85-DET-133. Presented at the ASME Conference on Vibration and Noise, Cincinnati, Ohio, September 10- 13 1985.
4. Panossian, H.. "Structural Damping Enhancement via NOPD Technique", Journal of Vibration and Acoustics, Vol. 1 14, January 1992, pp. 10 I - 105.

AF98-185 TITLE: Coherent/Incoherent Radiation Fire Suppression Technologies

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop an advanced firefighting suppressant that will eliminate the use of environmentally hazardous materials.

DESCRIPTION: The search for an alternative to halon as fire suppressants as a result of the Montreal Protocol ban on ozone depleting substances has yielded few optimum replacements for current deployed systems. Newly-found chemically acting agents still pose unresolved toxicity questions. The Air Force is looking for innovative approaches to the suppression of fires that include the use of photochemical excitation to suppress fires to eliminate the use of chemicals. One possible way to cause suppression is affect chemical kinetics of critical combustion reactions by exciting critical radicals through exposure to selective intense coherent or incoherent radiation. The excitation and de-excitation of critical free radicals by means of the use of directed energy has been shown to interfere with critical chemical kinetic reactions. This effort looks to demonstrate the use of coherent or incoherent radiation to suppress or mitigate fires. A possible embodiment of a fire suppression system includes the use of high intensity pulsed coherent sources in conjunction with fiber optic cables.

PHASE I: Address the scientific feasibility of using coherent or incoherent radiation to suppress fires including a small scale demonstration of the principle.

PHASE II: Focus on designing and building a prototype system which incorporates a coherent or incoherent source including the development of coherent fiber optic bundles to deliver light to the fires. The system should demonstrate fire suppression With fiber optic bundles and should suppress a 3' x 3' heptane flame.

PHASE III DUAL USE APPLICATIONS: All commercial facilities and industries where advancements in firm suppression would increase the survivability of people and resources.

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1. Sorensen, P.G., Lorenzen, T., Hynne F., "Quenching of Chemical Oscillations with Light," J. Phys. Chem., 1996, 100, p. 19192-19196.
2. Buchachenko, A.L.,, Berdisnky, V.L., "Spin Catalysis of Chemical Reactions," J. Phys. Chem., 1996, 100, p. 18292-18299.

AF98-186 TITLE: Craze Resistant and Delamination Resist Transparencies with Buried Metallic Films

CATEGORY: EXPLORATORY DEVELOPMENT; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop methodology to combine Next Generation Transparency (NGT) and lamination technologies to enhance capabilities and lower costs.

DESCRIPTION: NGT technology will produce injection molded transparencies with excellent optics and low cost. Laminated face plies and special coatings will be needed for many applications, but use of the present day standard laminating procedures will produce finished transparencies with some of the same common failure modes as "old technology" transparencies. A common aircraft windshield design is a cast acrylic outer face ply, an interlayer, one or more polycarbonate structural plies, and a protective coating or sacrificial thin ply on the inner surface (cockpit side) of the windshield. Metallic films are sometimes used, often on the inner (cockpit) surface. Leading failure modes for this type of transparency are (1) crazing of the acrylic ply; (2) scratches, gouges and other mechanical damage; (3) delamination of the face ply; and (4) damage to the metallic film. Typical manufacturing has flat polycarbonate sheets laminated to flat as-cast acrylic using interlayer material. The laminate is then bent to the final shape, which stretches the acrylic face ply and creates built-in tensile stress in the acrylic. If used, a metallic film system is applied to the final part. Acrylic has a "memory," and when heated above 225 degrees F by in-service exposures it tries to return to it's original shape, creating additional tensile stress. The stress also tries to pull up the edges of the acrylic, aiding delamination. This "shrink-back" characteristic disqualifies acrylic from any aircraft with sustained flight much faster than Mach 2. New manufacturing techniques are needed to lower life cycle costs by reducing or eliminating some of the leading failure modes and increasing durability. Any innovative approach to achieve this objective are encouraged and will be considered. One candidate concept: Cast acrylic in a curved mold, with radius of curvature tighter (more curved) than the final transparency shape. Create the structural plies in their final curved shape or in a more curved shape using some manufacturing process. Metallic films, if used, would be applied to some surface between the polycarbonate and the acrylic. Laminate the curved as-cast acrylic to the structural plies and form the final part. The result should be a face ply with some built-in compressive stress, amount of stress highly dependent upon manufacturing techniques and other controllable factors. Compressive stress in the face ply would greatly inhibit or eliminate both crazing and delamination.

PHASE I: Use analyses and simple coupon tests to evaluate different manufacturing techniques and concepts, devise a feasible manufacturing approach, estimate costs, benefits, and payoffs, and select specific designs/products to make with the new technique. Phase I would also consider if compressive stress acrylic designs could be used on aircraft flying over Mach 2.5.

PHASE II: Creation and use of the manufacturing equipment and procedures derived in Phase I, manufacture of full size parts for non-flight testing, and performing suitable tests.

PHASE III DUAL USE APPLICATIONS: Any aircraft transparency, to specifically include side cockpit windows for large commercial passenger aircraft and windshields for military aircraft such as the. windshields for F-15, T-38, F-18, and V-22. Other possible applications include large windows in buildings and specialized windows in ground vehicles (vision blocks in tanks).

REFERENCES:

1. NTIS Accession # AD-A255548, Determination of Stresses on Laminated Aircraft Transparencies by the Strain Gage-Hole Drilling and Sectioning Method, Whitney T.J. and Stenger G.J., UDR-TR-90-106, Apr 92.

2. NTIS Accession #: AD-A250-852, Investigation of a Relationship Between Uniaxial and Biaxial Chemical Stress Crazing of Cast Acrylic, Bowman D.R., UDR-TR-90-127. Jan 92.

3. NTIS Accession #: AD-A235 943, Surface Acoustic Wave Technique for Craze Detection and Stress Measurement of Aircraft Transparencies, Shaikh, N., WRDC-TR-90-3082, Feb 91.

4. NTIS Accession #: AD-A218 680, Nondestructive Measurement of Residual Stresses in Aircraft Transparencies, Raju B.B. and West B.S., WRDC-TR-89-3099, Nov 89.

5. DTIC #: AD-D012 155, Frameless Transparencies for Aircraft Cockpit Enclosures, Patent application, Pinnell, William R., PAT-APPL-805 008m 4 Dec 85, Corporate Author Dept of the Air Force, Wash DC.

AF98-187 TITLE: Discontinuously Reinforced Metal Matrix Composite Materials for Advanced Air Force System

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop and characterize advanced discontinuously reinforced metal matrix composite materials.

DESCRIPTION: Advanced composites are required to meet the performance objectives of future Air Force systems. A discontinuously reinforced metal is a class of metal matrix composite whose reinforcement is a particulate, whisker, short fiber or flake, typically of a strong, stiff ceramic material. These materials are of interest for use in aircraft engine, structural and electronic applications, as well as space launch vehicles, spacecraft structures and space-based electronics. For example, these materials are critical to achieving full-life and increased stiffness in applications such as the F-16 Ventral Fin and the PW4084 Gas turbine engine fan exit guide vanes. Their application will enable the attainment of Air Force goals for global reach and global power. New approaches are requested to develop production methods, prediction tools, and fabrication schemes in the area of discontinuously reinforced metals for aerospace structural and electronic packaging applications which: a) significantly reduce the cost of producing a flight-worthy finished component; b) increase key materials properties such as fracture toughness, strength, stiffness, fatigue life, creep, and high temperature stability; c) enhance predictive capabilities for composite materials properties and processing in ways which widen the scope of application of discontinuously reinforced composites.

PHASE I: This program will focus on the critical issues which when successfully addressed, will provide proof of concept. Proposal should demonstrate reasonable expectation that proof of principle can be attained within Phase I, and show evidence of industrial interest in a commercially viable product.

PHASE II: This program will be structured to develop and refine those feasible concepts to the point where performance is demonstrated on a scale sufficient to permit an assessment of the ultimate application potential to help meet Air Force advanced materials needs.

PHASE III DUAL USE APPLICATIONS: The developed approaches would have broad military and commercial applicability due to the large number of commercial and military electronic, spacecraft, aircraft, and engine systems that have materials requirements of a very similar nature.

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1. Aluminum Composite Doubles Lifetime of F-16 Ventral Fin Advanced Materials & Processes , ASM International, Oct. 96 p.7.

2. Wright Laboratory Success Stories, A Review of 1996, WL-TR-97-6002 (See Item 5 below), Wright Laboratory, WPAFB, OH 1997, pp. 56, 151.

3. Micro-and Macrostuctural Factors in DRA Fracture Resistance, W. H. Hunt, Jr., T. M. Osmand and J. J. Lewandowski, Journal of Metals, Jan. 1993, pp. 30-35.

4. Mechanical Properties of Particulate-Reinforced Aluminum-Matrix Composites, S. V. Kamat, J. P. Hirth and R. Mehrabian, Acta metallurgica, Vol. 37, No. 9, pp. 2395-2402, 1989
5. Web sites: http://www.ml.wpafb.af.mil/Successes/96Success/aluminum.html
http://www.wl.wpafb.af.mil/sstories/ss30_96.htm

AF98-188 TITLE: Epitaxial Growth of Silicon Carbide (SiC)

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop advanced, innovative epitaxial processes for the growth of silicon carbide for electronic applications.

DESCRIPTION: Advanced Air Force systems will require new and novel semiconducting materials to meet challenging power, frequency, speed, and temperature requirements. Conventional semiconductors such as bulk silicon and gallium arsenide cannot meet these requirements. Silicon carbide has many unique properties such as wide band gap, high breakdown field and physical strength, which make it attractive for high temperature and high power applications. This task seeks to develop improved and innovative approaches for the growth of epitaxial silicon carbide. All polytypes are of interest as well as alloys or heterostructures of silicon carbide with III-V semiconductors. While homoepitaxy of SiC to bulk SiC is of primary interest, growth on new substrates will be considered. The offeror is reminded that this is a materials task and projects that are primarily device development or device processing will be considered nonresponsive.

PHASE I: Address process development and initial testing to show proof of concept. Modeling studies of growth processes or materials properties are appropriate. A deliverable of a representative test sample to the government is encouraged.

PHASE II: Develop the advanced semiconducting material or process to demonstrate the potential application. Modeling studies of growth processes or materials properties are appropriate. Deliverables of test materials to the government for testing are encouraged.

PHASE III DUAL USE APPLICATIONS: Microwave devices made from SiC will exhibit high power, high frequency operation (e.g. 20 watts in X-band at room temperature) with higher package density and reduced cooling subsystem requirements. In addition, the high temperature nature of SiC permits the development of a host of harsh environment electronic devices. SiC electronics have many commercial applications. The automotive industry needs reliable materials and devices for the high temperature, corrosive, dirty environment in an automotive engine. Additionally, one of the planned uses in military aircraft, namely, on-engine flame detectors (i.e. in the engine during flight) is directly transferrable to civilian aircraft. The development of improved epitaxial growth processes for SiC will be required to successfully commercialize these high temperature, high power devices.

REFERENCE: Sher, A. et al. "Mechanical Properties of Semiconductors and Their Alloys," SRI Inc, AFOSR-TR-91-0006 AD No: A231820.

AF98-189 TITLE: Life Prediction of Advanced Materials in Aggressive Environments

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop innovative experimental and analytical techniques to measure damage accumulation in materials exposed to aggressive environments.

DESCRIPTION: Materials subjected to cyclic loading while exposed to aggressive service conditions undergo a process of microstructural damage accumulation leading to eventual failure of the component. The total useful life of a material whose life-limiting property is fatigue (either low- or high-cycle fatigue) consists of a crack initiation life and a crack propagation life. For many cyclic loading conditions in aggressive environments, the crack initiation life is a very large fraction of the material's total fatigue life. In many cases, the microstructural damage accumulation from fatigue loading can not be detected until a large crack is formed very near failure. New innovative experimental and analytical methods to measure damage accumulation as a function of time under fatigue loading in aggressive environments are required to enhance the life prediction of structural materials. Of particular interest are metallic and ceramic structural materials for service in high temperature corrosive environments.

PHASE I: Develop the experimental and/or analytical technique(s) to measure damage accumulation in metallic and/or ceramic structural materials tested in aggressive environments. Establish the feasibility of the technique on laboratory specimens tested under cyclic loading conditions. Develop algorithm(s) to predict the useful life of material as a function of

temperature, load, frequency, hold time, and environment.

PHASE II: Further development of the technique(s). Delivery of the experimental hardware for the measurement of damage accumulation in metallic and ceramic structural materials tested in aggressive environments. Delivery of the software code for the life prediction of these structural materials as a function of temperature, load, frequency, hold time, and environment.

PHASE III DUAL USE APPLICATIONS: The experimental and analytical techniques developed to measure damage accumulation in materials exposed to aggressive environments will be useful for a wide variety of commercial applications to include, but not be limited to, commercial aircraft (airframe and engines), land-based turbine engines for electrical power generation, transportation vehicles of all kinds, and other aerospace and industrial applications of metallic and ceramic structural materials.

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3. Nicholas, T. and Zuiker, J. R., On the Use of the Goodman Diagram for High-Cycle Fatigue Design, Int. J. of Frac., Vol. 80, pp. 219-235, 1996.
4. Zawada, L. P. and Lee, S. S., Evaluation of the Fatigue Performance of Five CMCs for Aerospace Applications, Fatigue '96, G. Lutjering and H. Nowack, Eds., Vol. III, Elsevier Science Ltd., 1996.

AF98-190 TITLE: Integrated Substrate and Thin-film Design Methods

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop methods for safe and affordable integrated design of substrates, thin-films, and their interfaces.

DESCRIPTION: Whether for extension of operating life, performance enhancement, or nano-scale functionality, the growth and/or removal of thin film materials (including coatings) for Air Force applications have established a need for a process modeling of material interfaces between and among various metals, ceramics, semiconductors, and polymers to assess properties and effluents for environmental compliance. A capability to simulate growth/removal conditions is needed to either ensure environmental compliance and/or control desired stoichiometries and crystallographic parameters of interest. This is in addition to the more macroscopic parameters associated with temperature/pressure gradation and rates. More widespread application of embedded 'nanostructured' materials and/or devices from monitoring temperatures and/or vibrations in critical engine components to agile and conformal threat/detection sensors via micro-electro-mechanical systems (MEMS) is limited by the lack of a design environment which can integrate so-called nano or molecular-level design with structural design of monolithic and/or composite materials. Complementary and/or alternative computational methods to intractable molecular modeling methods are required which leverage existing molecular and structural design tools and enable their integration. In Phase I, investigations will be accomplished to determine the capabilities and performance these new methods may have to offer. Materials of immediate interest include high temperature intermetallics, composites, electro-optical semiconductors, and polymers. Phase II will focus on the development of promising design tools, emphasizing their application to specific thin-film materials design.

PHASE I: Demonstrate the computational tractiveness of new methods involving substrate and thin-film growth/removal design with varying stoichiometries and crystallographic requirements to effect optimal properties, waste stream and environmental compliance.

PHASE II: Develop a generic capability to design the growth/removal process for desired substrate and/or thin-film to optimize performance (thermal, strength, magnetic and optical properties) of the combined thin-film and substrate material, while ensuring environmental compliance.

PHASE III DUAL USE APPLICATIONS: Dual use of this exploratory research is expected in areas involving the integrated substrate and thin-film designs for extension of operating life, performance enhancement, or nano-scale functionality. Specific examples include the growth of novel new materials - the design of a recipe for a nano-scale composite wear coating for a complex surface of a miniature momentum control device for a space probe; in the life extension of aircraft landing gear - the design of the tooling substrate for uniform plating of complex geometry, particularly internal surfaces such as a nose gear trinion can extend component life, avoid expensive rework and premature failure; and in the fatigue crack inspection of engine components - the design of micro end-effectors for cleaning, coating and/or inspecting intricate difficult to reach surfaces.

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5. E. S. Machlin, Materials Science in Microelectronics, Giro Press, Croton-on-Hudson, N. Y., 1995.

AF98-191 TITLE: Near Real-time Monitoring of Thin-film Materials and Their Interfaces

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop near real-time monitoring methods for the controlled growth and/or removal of thin-film materials.

DESCRIPTION: With the advent of thin-film composites and multi-layer coatings, atomic-scale monitoring of crystallographic information and stresses will become increasingly important. As compounded by material gradation and interface requirements, 2D uniformity and 3D topographies will drive yet more precise process control, e.g., in more integral micro-electro-mechanical systems (MEMS) and multi-property coatings ranging from threat/detection applications to gradient multi-layer coatings for higher operating temperature engine components all of which must be grown or removed under environmentally compliant conditions. Many existing in situ monitoring methods (e.g., optical methods) are limited to processes below 800 C, thereby limiting thin-film process thicknesses and rates. Simultaneous rapid assessment of a number of variables controlling ultimate specimen quality such as micro-chemistry, surface roughness, interface quality, grain size, preferred orientation and residual stresses are of particular interest. Future advances in materials research will require near real-time in situ data which can be used to automate materials process modeling and expedite the control of gradient thin-film growth and/or removal. Improvements are needed in sensing and signal processing over a wide range of temperature, i.e., 400 C to 1400 C, via monitoring methods which depend upon fixed time integration (the limitation of "counting" statistics, e.g., the Poisson distribution) to achieve adequate signal-to-noise ratios which often preclude real-time monitoring for purposes of process control.

PHASE I: Demonstrate the feasibility of in-situ sensing across a broad range of temperature and processing (growth and removal) conditions to monitor microchemistry, morphology and stresses of multi-layer thin-film interfaces, i.e., inter-layer and film-to-substrate. Materials of immediate interest are performance enhancement films of replacement components for aging aircraft to include high temperature intermetallics, composites, and inorganic electro-optical materials.

PHASE II: Develop a generic capability for in-situ near real-time monitoring across a broad range of processes and conditions involving multi-layer films together with the ability to predict the performance (thermal, strength, magnetic and optical properties) of the combined film and substrate.

PHASE III DUAL USE APPLICATIONS : Dual use of this exploratory research is foreseen for the process control of gradient thin-film materials. More specifically, thin-films for extreme environments such as thermal and wear protection for automotive, aircraft, and/or space propulsion systems. Specific examples include real-time process monitoring of surface roughness and microchemisty for painting, cleaning or inspecting of aircraft components, real-time process monitoring of film stresses for ultra-high vacuum processes such as molecular beam epitaxy, and real-time process monitoring of grain size for medium vacuum charged-ion plasma growth processes such as magnetron sputtering,

REFERENCES:
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2. A. P. Sutton and R. W. Balluffi, Interfaces in Crystalline Materials, Oxford Science Pubs, New York, 1995.
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Handbook of Optics, Vols. I and II, McGraw-Hill, New York, 1995.
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AF98-192 TITLE: Advanced Coatings Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop advanced aircraft coating systems capability of 30+ years service life.

DESCRIPTION: Aircraft painting/stripping/repainting processes and handling the associated hazardous waste is one of the highest cost maintenance activities in the Air Force. As a result, in late 1993 a USAF Paint Technology Task Force was chartered to establish a strategy for the Air Force paint removal and coating systems of the future. The Air Force Coating System Strategy applies to almost all operational aircraft and identifies aircraft coating system requirements from now until beyond the year 2003. In addition to environmental compliance, the strategy clearly defines long term coating system performance parameters significantly beyond the current state-of-the-art.

An advisory panel of internationally recognized experts in the fields of coating technology and corrosion science and engineering from industry and academia, was chartered to study the potential of a basic research contribution to ameliorate the aircraft paint issue leading to recommendations for a programmatic course of action. As result of that study, the following four areas of basic research activity were identified as enabling for the Air Force to meet its stated objectives by the year 2003.

1. Investigation of synthesis/structure/property relationships for surface treatments, primers and matte topcoats.
2. Identification of degradation mechanisms of polymers in matte coatings and subsequent development of appropriate models for performance predictions.
3. Synthesis of advanced materials (polymers, additives, pigments, inhibitors) for new coating systems.
4. Investigation of novel coating removal technology.

The Air Force has established basic research programs in the above enabling technology areas with participation by the top researchers in the country. Although there are ongoing activities to address environmental compliance, AF requirements are unique in the areas of 30-year life and removal/reapplication of topcoats. Previous national and international research activities in the above areas lack a fundamentals approach, are somewhat unfocused and do not address requirements unique to the Air Force. Research and development programs are sought which address the unique operational requirement of 30-year life.

PHASE I: The establishment of viable approaches to addressing key elements of the above enabling technologies are sought in Phase I.

PHASE II: Further develop and optimize the elucidation of mechanisms, development of models, synthesis of advanced materials and/or development of novel paint removal techniques using the approaches established in Phase I.

PHASE III DUAL USE APPLICATIONS: The commercial aircraft industry will benefit because much of the technology developed will be directly applicable. The auto industry also has a great need for corrosion protection as well as a need for predicting and extending the life of coatings for cars and trucks.

REFERENCE:
Report of the AF Blue Ribbon Advisory Panel on Aircraft Coatings, Part 1 - Basic Research.
Web Site: http://www.ml.wpafb.af.mil/facilities/ctio/default.htm

AF98-193 TITLE: Matrix Materials for High Performance, High Adhesion Sealants and Gap Treatments

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop higher performance matrix materials for sealants and alternate gap treatment materials

DESCRIPTION: There is a need for better, high adhesion matrix materials to provide the base for integral fuel tank sealants and gap treatment materials. In regard to fuel tank sealants, current matrix materials such as polysulfide, polythioether, and fluorosilicone elastomers all have some weaknesses, as the Air Force still has significant maintenance and repair caused by sealant leakage. For elastomeric fuel tank sealants, adhesion to the aged polyurethane fuel tank coating has been known to be a repair problem for many years. Innovative approaches are sought to develop better matrix materials for sealants. Improvements in adhesion and fuel resistance (low swell) are sought, while maintaining the required low temperature flexibility of -54 C (-65 F) and other sealant mechanical and physical properties. An improvement in sealant thermal/oxidative stability above the current 121 C (250 F) is also desirable for future systems. In regard to gap treatment materials, modern aircraft structures require electrical continuity across the outer skins (outer mold lines) for shielding and radar performance. Aluminum alloy and graphite/polymer composite structures match at gaps that span up to 0.7 cm. Currently, metal particle-filled elastomers such as polysulfides and polythioethers are used to provide the electrical continuity across these gaps. These materials take an excessive time to cure and do not have the mechanical performance to handle the strain levels for the hundreds of flight hours required. Improved gap treatment materials are required that have electrical conductivities at least 0.5 ohm-1-cm-1. In addition, these materials must have 50 percent minimum ultimate elongation across the temperature range of -55 to 120 C while maintaining electrical conductivity. They must be processable at the depot level in less than one hour, and have storage capability of over one year in standard shop environments. While maintaining the required properties of gap treatment materials, improvements are desired in adhesion to composite and metallic materials, in low temperature flexibility and elongation at -55 C (-67 F), in better resistance (low swell) to fuel, hydraulic oil, lubricating oil, and other

fluids, in shorter cure times at ambient or near ambient temperature, in longer shelf life for gap material components, or in the development of an inherently conductive gap treatment material. Gap treatment matrix materials are not limited to cured elastomers, but the low temperature flexibility requirements and fluid resistance requirements must be reasonably demonstrated to be met for other proposed materials such as thermoplastic elastomers.

PHASE I: Define, determine feasibility, and synthesize, modify, or develop preliminary high performance matrix materials suitable for fuel tank sealant and gap treatment applications. Select and evaluate promising techniques for formulating, curing and/or applying the candidate materials.

PHASE II: Select candidate matrix material(s) for development of a high performance sealant, gap treatment material, or for both applications. Develop a completely formulated sealant and/or gap treatment material and evaluate its performance in meeting Air Force requirements and goals. Further develop, optimize, and scale up candidate sealant(s) and/or gap treatment material(s) from bench scale to larger quantities for extensive requirements testing. Develop and execute a technology transition plan for the best materials to commercial application.

PHASE III DUAL USE APPLICATIONS: The materials and technology developed under this program would have numerous dual-use applications. The most obvious is for sealing commercial aircraft fuel tanks and for form-in-place seals for the chemical process industry. All commercial applications requiring EMI shielding could benefit from the proposed program. Rapid ambient temperature cure sealants could replace precured elastomeric gaskets for rapid repair/maintenance of fluid containment systems. High adhesion sealants could partially replace prebonded metal/seal components. With a developed thermal stability increase for the materials, various automotive fluid containment applications would be possible.

REFERENCES:
1. Usmani, A.M. et al, Interfacial Considerations in Polysulfide Sealant Bonding, Rubber Chem. and Tech., 54 (5), 1081 - 1095 (1981).
2. Jones-Meehan, Corrosion Resistance of Several Conductive Caulks and Sealants from Marine Field Test and Laboratory Studies with Marine, Mixed Communities Containing Sulfate-Reducing Bacteria, NRL/PR-92-094-333, ASTM, 27, 217-233 (1994).

AF98-194 TITLE: Ballistic Damage Tolerant Composite Materials for Unhabited Aerial (UAVs) Structural Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop innovative approaches with improved ballistic damage tolerance of advanced high performance composites suitable for airframe structures.

DESCRIPTION: UAV will be used in high threat operations and consequently, will have a high probability of being damaged by ground-to-air defenses. Innovative structural composite materials must be developed that offer both efficient structural performance and resistance to ballistic damage initiation and propagation, as compared to state-of-the-art composites. Novel approaches to achieve this performance could include 2.5D and 3D composite preforms; hybrid fiber systems; out-of-plane reinforcements; novel particulate, fibril, or whisker matrix toughening; interleaved hybrid materials; or integrated structural elements.

PHASE I: Develop concepts for advanced composite materials with improved ballistic damage tolerance. Fabricate and test specimens to demonstrate improve ballistic damage tolerance and relevant static mechanical performance, as compared to state-of-the-art advanced composite laminates. Two criteria will be considered: (1) reduced ballistic damage and (2) enhanced resistance in the presence of ballistic damage. Candidate approaches exhibiting superiority in both aspects compared to conventional structural composites will be considered for further evaluation.

PHASE II: Select most promising candidate from Phase I testing and produce large-scale test specimens for ballistic impact damage performance and extensive mechanical property database development.

PHASE III DUAL USE APPLICATIONS : High performance composites with greater damage tolerance are also needed in civil aircraft airframes and turbine engine applications.

REFERENCE: Fulghum, D.A., "High-G Flying Wings Seen For Unmanned Combat" Aviation Week & Space Technology, 145(20), Nov 11, 1996, p.58.

AF98-195 TITLE: Improved Film Adhesive for On-Aircraft Bonded Repairs

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop a structural adhesive for 180 degrees F service capable of long-term storage at ambient conditions, low-temperature cure, and vacuum processability.

DESCRIPTION: Adhesives for repair bonding, particularly for use on aircraft outside of the depot environment, must be improved in order to better utilize bonded repair technology to extend the lives of the aging USAF aircraft fleet. Currently, these adhesives are typically modified epoxies. The need for refrigerated storage of most existing epoxy film adhesives is often a problem, and limited shelf lives cause a significant amount of these materials to be wasted. Furthermore, most do not process at the lower temperatures desired for on-aircraft repair applications.

Two-part epoxy paste adhesives have been qualified for many applications in an attempt to resolve the above problems, however, they are not optimal for other reasons. Mixing of the components must be done in the correct proportions and can entrap air in the adhesive leading to porous bondlines (packaging can help resolve these issues). Also, the mixed pastes have limited pot lives, typically do not process well under vacuum pressure (higher porosity than films), and present a bondline thickness control problem. Finally, most two-part epoxy pastes do not have an optimal combination of shear strength (tested wet at 160 F - 180 F) and toughness (as measured by peel tests). Epoxy film adhesives that can be stored at ambient conditions have shelf lives much shorter than one year when stored at realistic temperatures (up to 90 F for ambient) and/or must be cured at higher temperatures than those desired for on-aircraft repair. Alternate adhesive chemistries, such as acrylics and urethanes, have advantages but do not provide the structural properties required, particularly at higher service temperatures. Efforts to develop epoxy systems using encapsulated curatives have shown promise. However, a film system designed to meet all of the on-aircraft repair requirements has not been developed. Another promising approach, again with epoxy chemistry, is the use of a latent catalyst that would allow for ambient stability with full cure obtained below 200 F.

PHASE I: Demonstrate the feasibility of an approach for developing a supported film adhesive that meets the following requirements: (1) mechanical properties per Type I of MIL-A-25463B and Type I Class 1 of MMM-A-132B while cured under vacuum pressure for a maximum of four hours at a maximum temperature of 200 F; (2) capable of delivering the above properties after storage at 90 F for 12 months, with 120 F storage preferable; (3) nontoxic/nonhazardous and environmentally friendly; and (4) out-time and handling characteristics typical of MIL-A-25463B film adhesives. Selected mechanical tests shall be performed to demonstrate the adhesive's potential to meet the requirements. This may be done using a paste version of the product rather than a film. Although long-term shelf life studies cannot be performed as part of the Phase I effort, the potential for the selected approach to meet the 12 month shelf life at 90 F shall be shown. Approaches may include encapsulated catalysts, latent catalysts or other.

PHASE II: Optimization of the selected approach with testing to demonstrate it meets the above specifications using a supported film version of the adhesive. Shelf life studies shall be conducted to demonstrate the 12 month storage stability of the adhesive.

PHASE III DUAL USE APPLICATIONS: The adhesive developed would be beneficial for repair of commercial aircraft.

REFERENCES:

1. Military Specification MIL-A-25463B, Adhesive, Film Form, Metallic Structural Sandwich Construction.
2. Federal Specification MMM-A-132B, Adhesives, Heat Resistant, Airframe Structural, Metal-to-Metal.
3. Kuhbander, Ronald J., Characterization of EA9394 Adhesive for Repair Applications, WL-TR-92-4069, Air Force Wright Laboratory, January 1994. DTIC Order No. AD-A279 166.
4. Hoffman, D. K., et al., Storage Stable Epoxy Resin Adhesives Based on Encapsulated Curatives, 28th SAMPE International Technical Conference, Volume 28, November 1996, PP. 481-494.

AF98-196 TITLE: High Temperature, Long-Service-Life Fuel Cell Bladder Materials

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop higher temperature and longer service life elastomeric materials for use in constructing aircraft fuel cell bladders.

DESCRIPTION: Current materials used to construct aircraft fuel cell bladders are temperature limited to approximately 180 F. Recent testing with JP-8 fuel showed that, after 28 days at 200 F, bladder inner-liner materials are severely degraded. Both the nitrile

and urethane technologies that are used today failed at 200 F, but passed at 160 F. Until recently, the maximum local and bulk fuel temperatures was 160 F for all aircraft. Now, however, some recirculation temperatures measured inside fighter aircraft are reaching 215 F. This is causing premature failures of the bladders.

In addition, the service life on current fuel cell bladders is too short to handle aging aircraft requirements. Normal bladder service life on some aircraft is only 4 -5 years, with some failures after 2 years. Failures have been due to seam disbonding, pinholes, and tears. A more durable material is needed to help extend the service life and avoid added maintenance costs.

Elastomeric material development is needed to develop new materials formulations that can handle 250 F fuel continuously and improve the durability over current materials. Creative technologies are sought that can provide materials to handle future aircraft fuel cell bladder manufacturing.

PHASE I: Define, determine feasibility, and develop preliminary high temperature and durability aircraft fuel cell bladder materials. Select and evaluate promising formulations of candidate materials.

PHASE II: Further develop, optimize, and scale up candidate material(s) from bench scale to larger quantities for extensive requirements testing. Develop and execute a technology transition plan for the best materials to commercial application.

PHASE III DUAL USE APPLICATIONS: The materials and technology developed under this program would have numerous dual-use applications. The most obvious is for commercial helicopter fuel cell bladders. Technology may also be applicable to military and commercial aircraft fuel hoses and fuel hoses used on other kinds of vehicles.

REFERENCE: Kalt, D.H., Report No. UDR TR-97-01, Fuel and Fuel System Materials Compatibility Test Program for a JP-8 + 100 Fuel Additive, (1996).

AF98-197 TITLE: High Temperature Superconducting Films

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop advanced materials and film processes to enable fabrication of HTS components for electronic and microwave applications.

DESCRIPTION: HTS materials offer the potential for significant performance improvements for a variety of Air Force applications. One application of particular interest to the Air Force is tunable HTS microwave filters. Innovative concepts for tuning, as well as improved thin film materials to allow increased filter tunability without unacceptably reducing the low insertion loss properties characteristic of HTS filters, are solicited. The Air Force is also very interested in the development of thick HTS films on flexible metallic substrates for high current density power applications. Critical to the successful development of this "coated conductor" is the development of buffer layers on appropriate metallic substrates to create a textured substrate on which the HTS film may be deposited. This task seeks to encourage the development of optimum buffer materials and innovative deposition processes which can be economically scaled-up to long-length conductors. This topic primarily addresses the development of materials and processing techniques, as opposed to strictly device development. However, devices may be examined as a part of the materials effort to demonstrate the improved properties of the materials.

PHASE I: Address process development and initial testing to demonstrate proof of concept. Delivery of a representative test sample or samples to the government is encouraged.

PHASE II: Develop and optimize the process or material to demonstrate the potential application and will plan for Phase III commercialization. Delivery of material samples to the government for testing is encouraged.

PHASE III DUAL USE APPLICATIONS: HTS materials technology has great potential for commercial applications. For example, HTS microwave filters may be used in wireless communication systems to alleviate growing cellular interference problems and improve frequency utilization. Several applications would benefit from the ability to alter the operating frequency of a device or to operate a given device at different frequencies. Commercial applications for HTS thick film coated tapes include motors, generators, transformers, current limiters, and magnetic energy storage.

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1. High-Temperature Superconducting Microwave Devices: Fundamental Issues in Materials, Physics, and Engineering, N. Newman and W. G. Lyons, Journal of Superconductivity, Vol 6, no. 3, Jun 1993, p 119-
2. "Electrically Tunable Coplanar Transmission Line Resonators using YBa2Cu3O7-xISrTiO3 Bilayers," A. T. Findikoglu, et al, Appl. Phys. Lett. V.66 no. 26 Jun 1995 p 3674-
3. "Coated Conductors: The Next Generation of High-Tc Wires," R. Hawsey and D. Peterson, Superconductor Industry Vol. 9, no. 3, p. 23, 1996.

AF98-198 TITLE: Materials and Processes for Development of Supramolecular Architectures for Optical Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop thin-film deposition techniques for linear and nonlinear optical applications based on supramolecular architectures

DESCRIPTION: Linear and nonlinear thin-film optical materials are needed in many commercial and military applications. These include space and aircraft communications and sensor systems, and coatings for eye protection from laser hazards. Not only are materials with suitable properties necessary, but it must be possible to process these materials into thin-films for devices that optimize their laser resistant properties. This program's goal is to investigate the use of the emerging thin-film deposition techniques based on supramolecular self-assembled architectures. It is desirable to assemble molecules with non-linear optical properties for applications such as optical limiting, as well as linear applications, such as high performance conformal optical filters. This new deposition technique enables one to control intermolecular interactions (energy transfer, charge transfer, information transfer, response transfer, etc.) from the micro to the macro scale. In electrostatic self-assembly (ESA) of thin-films, coatings are deposited layer-by-layer which provides process control at the molecular level. ESA thin film deposition techniques have been investigated as an approach to develop multi-responsive materials for optical applications. This technique provides a means of sequentially controlling the micro and macromolecular structure and morphology of thin films by providing versatility in molecular arrangement. The proposed effort should investigate ESA and/or other self-assembly thin-film deposition techniques that utilize non-covalent mechanisms (ionic, hydrogen bonding, etc.). In addition, the proposed effort can develop new thin-film deposition techniques of NLO molecules to protect against laser hazards. Non-linear and linear optical devices (e.g. rejection filters, graded optical limiters, rugate filters, and dielectric stacks) may be examined as part of a processing and materials effort to evaluate and demonstrate enhanced material performance.

PHASE I: During this phase the offeror will demonstrate the fabrication feasibility of thin-film materials and supramolecular architectures that satisfactorily demonstrates a proof-of-principle and identifies those materials/process issues which must be addressed during Phase II of the program.

PHASE II: Optimize the thin-film deposition processing technique for fabricating thin-film materials and supramolecular architectures with enhanced optical properties. Design, fabricate and characterize a test article based on the developed thin-film deposition technique that demonstrates enhanced optical properites.

PHASE III DUAL USE APPLICATIONS: Multi-responsive thin films and supramolecular architectures fabricated by self-assembly techniques are of interest to both the military and the commercial sector in applications which involve the fabrication of electrodes, microelectronic devices, opto-electronic devices, light emitting diodes, transistors, integrated optics, sensors, microelectrode arrays and photovoltaic devices.

REFERENCES:

1. Bein, T. (1992). Supramolecular architecture: Tailoring structure and function of extended assemblies. Supramolecular Architecture: Synthetic Control in Thin Films and Solids. T. Bein. Washington, DC, American Chemical Society. ACS Symposium Series 499: 1-7.
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5. Fou, A. C., D. L. Ellis, et al. (1994). Molecular level control in the deposition of ultrathin films of highly conductive, in-situ polymerized p-doped conjugated polymers. Materials Research Society Symposium Proceedings 328: 113-118.

AF98-199 TITLE: Frequency Conversion and Electro-Optical Materials

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop nonlinear optical materials and processes with superior properties compared to those presently available.

DESCRIPTION: Nonlinear optical (NLO) materials are required for a variety of Air Force appli-cations including electro-optic countermeasures, LIDAR, laser radar, optical signal processing, and optical interconnects. These applications require new laser

sources (optical parametric oscillators and harmonic generators) and electro-optic devices (directional couplers, guided-wave interferometers, and optical phase shifters). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical transperancy, difficulty in processing for devices, and other factors. Proposed efforts shall address inorganic or organic materials in bulk or thin-film forms which exhibit large second-order nonlinear effects. Strongest interest is in bulk crystals for frequency conversion in the 2-12 micron wavelength range including birefringent phasmatching, quasi-phase matching, and periodically poled materials and in thin films for guided-wave devices in the 0.7- to 1.5-micron range, particularly, in material processing technnologies to improve materials for device applications. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only as a minor part of a materials effort to evaluate and demonstrate the properties of the material(s).

PHASE I: The objective is to demonstrate the proposed growth or processing techniques.

PHASE II: The objective is to further develop the proposed material and relevant processes to fully demonstrate the material's properties and usefulness for commercial and military applications.

PHASE III DUAL USE APPLICATIONS: Materials technology is fundamental to all applications, military and commercial. Examples of commercial applications for NLO bulk crystals are LIDAR for environmental monitoring, medical lasers, and scientific instruments. Examples for NLO thin films are optical switches for cable TV, optical phase shifters for phased array radar, optical interconnects for electronic packages, and switching networks for communications.

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2. Dmitriev, V.G. , G.G. Gurzadyan, and D.N. Nikogosyan, Handbook of Nonlinear Optical Crystals. Springer-Verlag, 1991.

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AF98-200 TITLE: Methods to Measure Corrosion Kinetics in Aging Aircraft Aluminum

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop alternative techniques for measuring progression of corrosion damage.

DESCRIPTION: In order to control Air Force corrosion maintenance costs and assess airframe structural integrity, it is imperative to determine the rate at which corrosion damage accumulates in various aerospace structures. Progressive corrosion damage information is vital and currently there are limited techniques for quantifying corrosion kinetics, none of which are suitable for quantifying the rate in lap joints. Exploratory research and development efforts are needed to demonstrate the feasibility of new laboratory techniques suitable for quantifying corrosion kinetics in aircraft aluminum alloys either in-situ or post exposure to aircraft operational environments. Corrosion damage mechanisms to be examined include general, filiform, exfoliation, pitting, and stress corrosion cracking. Systems to be examined include lap joints and structural members.

PHASE I: Validation and comparison of the composed method with existing techniques to determine corrosion rates.

PHASE II: Development of a prototype laboratory instrument to measure corrosion kinetics .

PHASE III DUAL USE APPLICATIONS: Corrosion kinetics measurement tools will be useful and applicable in predicting and assessing the structural integrity of the aging military and commercial aircraft fleets.

REFERENCES: Tri-Service Corrosion Conference Proceedings, 1994. Advanced Materials and Processes Technology Information Analysis Center (AMPTIAC), 210 Mill St, Rome, N.Y. 13440-6916, Phone: (315) 339-7117, FAX: (315) 339-7107, E-Mail: gnash@rome.iitri.com

AF98-201 TITLE: High Temperature Structural Materials for Advanced Air Force Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop and characterize advanced high temperature structural materials.

DESCRIPTION: Advanced high temperature structural materials are required to meet the performance objectives of future Air Force systems. For example, these materials are critical to doubling the propulsion capability of gas turbine engines, and for extending the range of uninhabited air vehicles. Their application will enable the attainment of Air Force goals for global reach and global power. New approaches are requested to develop and characterize: (a) advanced high temperature structural ceramic composites (1800F to 3500F, excluding carbon-carbon composites); (b) intermetallic materials and composites (1800F to 3000F, excluding nickel aluminides) and (c) model forming processes for advanced structural materials. For ceramic composites, research is limited to continuous ceramic fiber reinforced ceramic matrix systems and may include the following: (a) new, unique ceramic composite development; (b) novel matrices suitable for continuous fiber reinforcement (applicability to composites must be demonstrated), (c) fiber/matrix interface treatments engineered for toughened behavior and stability; (d) continuous ceramic fiber development; (e) test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain, etc.) as a function of temperature and loading history; and, (f) analytical modeling of composite behavior. For intermetallic materials, research is limited to: (a) methods for modeling intermetallics which lend insight into chemistry selection and control, as well as microstructural selection and control; (b) methods of synthesizing intermetallics to provide chemistry and microstructural control on a submicron scale while maintaining the ability to vary and control the final microstructural scale; and, (c) methods for environmental protection of intermetallics (both monolithic and composites) aimed at providing long life under cyclic oxidation conditions. For modeling of forming processes, research may include modeling of (a) the unit forming process; (b) the material behavior in response to the demands of the unit process; (c) the interface between the work piece and the die or mold; and, (d) novel methods for obtaining physical property data and constitutive equations for insertion in models.

PHASE I: This program will focus on the critical issues, which when successfully addressed, will provide proof of concept. Proposal should demonstrate reasonable expectation that proof of principle can be attained within Phase I.

PHASE II: This program will be structured to develop and refine those feasible concepts to the point where performance is physically demonstrated on a scale (coupon, subelement, and/or prototype as appropriate) to permit an evaluation of the ultimate application potential to help meet Air Force advanced materials needs.

PHASE III DUAL USE APPLICATIONS: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchangers, power turbines, and hot gas filters are also pertinent. For the turbine applications in particular, these materials permit more efficient and clean operation, saving precious natural resources while limiting pollutant emissions.

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AF98-202 TITLE: Novel Nondestructive Evaluation Technology for Aerospace Components & Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop nondestructive evaluation techniques that permits detection of flaws and residual stresses in structural components.

DESCRIPTION: The Air Force is interested in research and development projects directed toward potential applications of new and novel NDE techniques to detect and quantify flaws in a range of components, as well as understanding the changing state of residual

stress at various locations on the surface of a structural component. Such programs should characterize a particular class of flaws and offer a method for their detection and quantitative assessment. The Air Force is also interested in novel NDE methods to provide stress field mapping on the surface of aerospace structures, providing a relative indication of surface residual stress fields. Examples of the flaw typed that are of interest include the very small flaws that result during high cycle fatigue, corrosion of aluminum aircraft structure, and the mapping of wide area fatigue damage in older aircraft. Another long standing NDE problem deals with the assessment of adhesively bonded components. Any proposed work in this area would have to show that NDE measurements are applicable to well known models of adhesive joint performance. Such work must not be a simple correlation of performance with an NDE signal. In the area of residual stress measurement, the use of x-ray diffraction has long been utilized. However, these measurements can be time consuming when attempting to map stress fields on the surface of an actual structural component. An investigation of the trade-off involved in the use of any proposed NDE technique should lead to a rational engineering use for the technique. Special consideration will be given those proposals that address materials and NDE methods that have both military and civilian applications, i.e., dual usage.

PHASE I: Programs in these areas should address the requirements and goals of the proposed efforts, as well as initial formulation, testing, and evaluation required for proof of concept.

PHASE II: The process or design concepts from Phase I would be developed through optimization and scale-up efforts to establish feasibility for manufacture and wide scale use of any instrument proposed. Either process or design concepts would lead to a marketable product after a Phase III program.

PHASE III DUAL USE APPLICATIONS : With the world wide emphasis on reliability and initial quality, the potential applications of new NDE techniques could be conceivably quite large. One example would be the development of an NDE method to measure residual stress in turbine engine disks (applicable to military and civilian engines). Improved corrosion detection methods would be applicable to both the military and civilian aircraft fleets.

REFERENCES:

1. The Nondestructive Testing Handbooks, Second Edition; Vol. 1, Leak Testing, Ed. R. C. McMaster; Vol 2, Liquid Penetrant Testing, Ed. R. C. McMaster; Vol. 3, Radiography and Radiation Testing, Ed. L. E. Bryant; Vol. 4, Electromagnetic Testing, Ed. M. L. Mester; Vol. 5, Acoustic Emission, Ed. R. K. Miller; Vol. 6, Magnetic Article Testing; Ed.s J. T. Schmidt & K. Skeie; Vol. 7 Ultrasonic Testing, Ed.s A. S. Birks & R. E. Green, Jr.; Vol. 8, Visual and Optical Testing, Ed.s M. W. Allgaier & S. Ness; Vol. 9, Special Nondestructive Testing Methods, Ed. R. K. Stanley; American Society for Nondestructive Testing, Columbus, OH.
2. Nondestructive Evaluation, A Tool for Design, Manufacturing, and Service, D. E. Bray and R. K. Stanley, 1989, McGraw-Hill Book Co., New York, NY.
3. Nondestructive Testing Handbook, 2nd Edition, R. Halmshaw, 1991, Chapman & Hall, London.
4. Metals Handbook: Nondestructive Evaluation and Quality Control, Vol. 11, 1976, The American Society for Metals, Metal Park, OH.
5. Nondestructive Characterization of Materials, R. A. Kline, 1992, Technomic Publishing, Lancaster, PA.

AF98-203 TITLE: Oxidation Resistant Materials and Light Weight Tankage Materials for Military Space Plane Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop Military Space Plane (MSP) materials & processes for oxidation resistant coatings; out of autoclave resins; and cryogenic propellant tanks.

DESCRIPTION: The intent of this procurement is to look at innovative approaches to field inspectable and repairable oxidation resistant coatings for Thermal Protection Systems (TPS); leading edge and control surface materials; resins for out of autoclave processing of large composite structures and tanks; and materials for light weight, reusable cryogenic propellant tanks.
With the increasing importance of military space operations to the Global Reach, Global Power, and Global Presence capabilities of the Air Force, it is recognized that achieving safe, reliable, affordable, and routine access to, through, and from space will become more important to national security. The Air Force interest in reusable launch vehicles stems from the potential to achieve a 10-fold to 100-fold reduction in annual operating costs compared to existing expendable launch vehicles. Military Space Plane (MSP) is a multi-mission vehicle which has a 2 hour turn about time and can fly anywhere over the earth -- not just a space lift vehicle. To do all this, the MSP must have a cross range ability of 1200 miles and be all-weather capable. These requirements translate to higher temperature, more durable Thermal Protection Materials (TPS) (not tiles and blankets) with oxidation resistant coatings which are field inspectable and repairable. Resultant leading edges and control surface materials (metals, oxidation resistant carbon-carbon, ceramic matrix composites) must withstand the MSP environments and the coatings must protect the hot structure substrate from

heat fluxes of 136 W/cm2 (stagnation regions) and be repairable within 2 hours. Moreover, the mass fraction to reach orbit in a single stage is approximately 90%, making advanced materials enabling to meet MSP goals. As an example, composite hydrogen tanks result in a 6% reduction in the tank weight over conventional aluminum tanks and a 40% system reduction through the integration of tanks as a part of the vehicle substructure. To meet the mass fraction and single stage to orbit goals, composite tanks must become less permeable to LH2 (reducing the requirement to carry extra fuel) and be very large (reducing the weight based on higher specific gravity materials). Thus, either leak tight adhesives need to be developed or the tanks will be single piece requiring process techniques which can be completed out of an autoclave. Similarly, composite LOx tanks will dramatically decrease system weight. Light weight, large (greater than 17 M diameter by 30 M long) structures and propellant tanks are required. Proposal may address single materials and process technology and need not address all applications identified in the Description and Objective. The proposals will be evaluated by personnel from Wright Laboratory Materials Directorate and Phillips Laboratory Structures and Controls Division.

PHASE I: Explore coupon level materials for leading edge and control surfaces and demonstrate that they can meet preliminary MSP goals. If repair coatings are chosen, tailored coating repair techniques should be evaluated on coupons in the MSP environment to determine adhesion to the substrate, oxidation resistance and demonstrate repair techniques. Tank materials and resins must be evaluated in the presence of liquid hydrogen and oxygen to determine propellant effects on materials and suitability for reusable cryogenic tanks.

PHASE II: Scale-up and demonstrate the most promising materials systems through subscale components to demonstrate the materials and processes selected. The subscale components will be evaluated in an MSP environment; characterized to provide a preliminary database and assessed to determine applicability to meet preliminary MSP goals.

PHASE III DUAL USE APPLICATIONS: Structural thermal protection materials and repairable thermal protection systems are crucial to the success of any reusable launch vehicle (RLV). In addition to military interest, NASA and the commercial world are interested in RLV since the potential to reduce launch costs 10-fold to 100-fold compared to the existing expendable launch vehicles. Consequently, the need for durable thermal protection systems and repairable TPS extends beyond MSP. In addition RLV will need over 10,000 pounds of oxidation resistant leading edge materials. Out of autoclave composite and other approaches to light weight LH2 and LOx tanks will enable the success of any single stage to orbit reusable launch vehicle (RLV).

REFERENCE: NASA RLV technologies can be found at the website: http://rlv.msfc.nasa.gov. Reference to the Military Space Plane can be found at the website: http://www.plk.af.mil. Specific references to this repairable coatings are omitted to promote new and creative ideas.

AF98-204 TITLE: Micromechanical Failure Prediction Using Heterogeneous Elasticity

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop a method to model growth of discrete damage in composite laminates with variable fiber spacing.

DESCRIPTION: The lack of a rigorous failure criteria for composite laminates may be the single most important reason for the high material qualification costs, overdesign weight penalties, and use limitations associated with composites on aircraft. It is clear that the failure modes that infect composite laminates have their origins in the micromechanical domain. The analysis method to be developed for the present SBIR effort is the modeling of the micromechanical response of composites in which individual fibers are discretely represented and variable fiber spacing is present. The required analysis for both program phases shall be limited to linear elastic transversely isotropic constituent materials. The model shall be capable of predicting the thermal/mechanical stress field for a composite laminate with parallel arbitrarily spaced circular cylindrical fibers. All fiber diameters are not necessarily equal. Damage in the form of arc debonds and cracks in either constituent at arbitrary locations will be represented. The model shall allow for arbitrary loading with mixed boundary conditions (displacement and tractions). The model shall also be capable of multiple scale or global/local material representation. The proposal is expected to include a demonstration of the proposer's current capability to model a heterogeneous body consisting of a matrix material reinforced by two rows of fibers aligned parallel to the x-axis. The body is subjected to a constant axial strain in the x-direction. The constituent material properties and geometry are given in Reference [1]. The precise geometry of the proposal problem is given in Figure 2(a) of Reference [1]. As a minimum, the proposal is expected to include line plots of the micromechanical transverse normal stress predictions as shown in Figures 3-6 of Reference [1]. Since the results of Reference [1] were obtained with what is now a 20 year old technique, do not regard the solutions as being perfectly correct.

PHASE I: Develop a 2-D analysis computer code for predicting the thermal/mechanical stress field for a composite laminate with parallel arbitrarily spaced circular cylindrical fibers. The contractor shall develop the methodology to model arc debonds and cracks in either constituent at arbitrary locations. The computer code shall be a contract deliverable.

PHASE II: Develop a 3-D analysis computer code to model a composite system with fibers that lie in parallel planes, but are otherwise arbitrarily oriented in space. Also, the code is to incorporate discrete damage modeling. The computer code shall be a contract deliverable.

PHASE III DUAL USE APPLICATIONS: The potential exists for a user-friendly, interactive computer code that can accurately predict progressive damage and failure of composite laminates under arbitrary loading, and can aid in load-carrying assessments of composite structures. As conceived, the end product will be a powerful analysis tool with wide applicability and high demand in the commercial and military aerospace industries, as well as in other industries where composites are utilized, such as automotive, marine and sporting goods.

REFERENCE: Pagano, N.J. and Rybicki, E.F.,"On the Significance of Effective Modulus Solutions for Fibrous Composites," Journal of Composite Materials, Vol. 8, p. 214 (1974)

AF98-205 TITLE: Processing of Functionally-Graded Thermoplastics for Process-Efficient Rocket Motors

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop the processing technology to coextrude functionally-graded thermoplastic tubes with advantageous cross-sectional property distributions.

DESCRIPTION: Existing coprocessing technologies impose excessive limits on the range of property variation in functionally graded materials due to the associated disparities in processing characteristics. The ability to coextrude, or otherwise produce, functionally-graded tubular articles with substantial variation in mechanical and thermal characteristics across the tube wall would greatly reduce the cost and increase the performance of many solid and liquid rocket components. For example, the functionality requirements for solid rocket motors (SRMs) include high hoop-strength and upper use temperature from a case, thermal insulation and ablative protection of the case with insulation, and energetic propulsion capability from a highly filled thermoplastic elastomer, propellant. Example materials to be coprocessed include, but are not limited to, thermotropic liquid crystalline polymers, polymeric nanocomposites, thermoplastic elastomers, and fluorinated thermoplastics. For liquid rocket ducting and tanks which transport and store cryogenic liquid rocket fuels, the functionality requirements include high hoop-strength from an external wall and thermal insulation and barrier protection from an interior wall. One step processing of these materials would lead to a tremendous cost savings over current manufacturing technology. Additionally, coprocessing and/or functional grading will lead naturally to improved adhesion between layers, thus addressing the bondline-failure mechanism which accounts for 40% of solid rocket motor failures. The materials which are best suited for the three functions within the SRM invariably possess much different processing characteristics, most notably melting temperature, rheological properties, and surface properties. Example materials to be coprocessed include, but are not limited to, thermotropic liquid crystalline polymers, polymeric nanocomposites, thermoplastic elastomers, and fluorinated thermoplastics. Die designs which accommodate large thermal gradients and additionally lead to advantageous interfacial mixing will be a critical technological development. Additionally, careful selection of materials based on melting temperatures, rheological properties, and interfacial characteristics will be important.

PHASE I: Develop and demonstrate a polymer processing technology to coextrude, or otherwise manufacture, functionally-graded tubular articles from thermoplastics resulting in advantageous property distribution across the wall thickness of the tubes. The processing techniques should be developed for use of polymeric materials ranging from liquid crystalline polymers to fluorinated thermoplastics and nanocomposites. Efforts should also include full materials and mechanical characterization of the resulting functionally-graded articles. In addition to innovative concepts, emphasis should be placed on low-cost techniques that will yield rapid production cycle-time.

PHASE II: Expand and optimize the technology developed in Phase I to fabricate, in one step, functionally-graded tubular structures with material selection relevant to a solid-rocket motor case and a liquid rocket duct or storage tank. The effort should include full materials and mechanical characterization of the resulting functionally-graded articles to evaluate the structures with respect to design criteria and performance requirements for solid and liquid rocket motors. Additionally, effort may also be directed toward expanding the technology developed in Phase I to the fabrication of functionally graded materials in other forms and shapes.

PHASE III DUAL USE APPLICATIONS: Commercial potential exists for the manufacturing of functionally-graded tubing and ducting possessing, for example, external barrier protection against one thermal/chemical environment, and internal barrier protection from another environment. This processing technology will have a wide range of applications from the automotive to the packaging industries.

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1. Kim, J.K. and Han, C.D., Polymer-Polymer Interdiffusion During Coextrusion, Poly. Eng. Sci., 1991, 31, 258-269.
2. D.R. Paul, Polymer Blends, Academic Press, New York, 1978.
3. Taraiya, A.K. and Ward, I.M., "Production and Properties of Biaxially Oriented Polyethylene Tubes," J. Appl. Poly. Sci., 59, 627-638 (1996).

AF98-206 TITLE: Munition Flight Mechanics Research

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop innovative concepts for advanced munition airframes and navigation, guidance, and control.

DESCRIPTION: New and innovative concepts for the area of air delivered conventional munitions and armament is sought. The Weapon Flight Mechanics Division conducts research and directs exploratory development of advanced munition airframe concepts and the guidance, navigation and control (GN&C) of munition airframes. Munition airframes under consideration include air-to-air missiles, air-to-surface munitions (general purpose bombs and hard target penetrators), submuntions, and projectiles. Areas under consideration for munition airframes include aerodynamic shaping, folding fins and wings, carriage and release technologies (especially mulitple carriage and release of submunitions), and innovative control techniques (i.e. reaction controls, body bending, etc.). Munitions integration on Unmanned Aero Vehicles is a key technology area. Areas of primary interest in navigation include very small, low cost inertial measurement units (IMUs), Global Positioning System (GPS) guidance, jam resistance GPS, and transfer alignment. Areas of interest in guidance technology include optimal guidance law development, target state estimators, and advanced adaptive autopilots.

PHASE I: Determine the technological or scientific merit and feasibility of the innovative concept. The merit and feasibility should be clearly demonstrated during this phase.

PHASE II: Produce a well-defined deliverable prototype.

PHASE III DUAL USE APPLICATIONS: The military end products or processes resulting from this topic will be used to develop advanced munition airframes and munition navigational, guidance, and control systems. Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan. Jam resistant GPS technology could be applied to commercial aircraft by potentially improving GPS operation in the midst of friendly or intentional jamming. Low cost IMU technology could be applied to commercial robotic devices or commercial remotely piloted surveillance vehicles. Innovative flight vehicle technologies could improve performance and other air foil products, i.e. wind turbines, turbomachinery, etc.

AF98-207 TITLE: Active Vortex Control

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop techniques to actively control the vortex shedding of a slender body using innovative micro-technologies.

DESCRIPTION: Unsteady, asymmetric vortices are produced along a slender cylindrical body when it is oriented at high angle-of-attack (AoA) to the incident flow. These vortices create significant aerodynamic forces which can de-stabilize the vehicle and diminish performance. It has been observed that such vortices shed from a tapered forebody are most influenced by perturbations originating near the tip. Various attempts have been made to control or alter these vortices by mounting strakes or fences, by deploying flaps, by placing suction, or blowing ports near the nose tip. Some of these measures have been successful, but are only necessary for a fraction of the total flight profile and incur weight or performance penalties. With the recent advances in miniaturized technologies, new and innovative methods for controlling these vortices may be found which would conform to the shape of the body when not needed and would not add a significant drag or weight penalty. This effort will demonstrate control techniques in both the subsonic and transonic velocity regimes up to a mach number of 1.2.

PHASE I: Multiple techniques for controlling unsteady vortex shedding from a slender cylindrical body, with a 3:1 ratio tangent ogive nose, at high AoA will be identified. These techniques may include new miniaturized technologies such as micro-electromechanical devices as well as other technologies such as piezoelectric devices and shade memory alloy devices, for example. The effectiveness of each technique in controlling the vortex shedding will be evaluated experimentally and will require an understanding of high AoA vortex dynamics.

PHASE II: The two most promising techniques identified in Phase I will be evaluated further in Phase II. The

effect of each technique will be optimized by parametric study. The stability and control of the slender body employing the new, optimized devices will be assessed both statically and dynamically using qualitative and quantitative experimental techniques. These results will be compared to those obtained for the baseline slender body configuration without any devices.

PHASE III DUAL USE APPLICATIONS: The demonstrated use of miniaturized technologies to alter the vortex shedding will improve the performance of future air-to-air missile configurations. Similarly, this technology applies directly to commercial aircraft by potentially improving performance and reducing drag. Moreover, these devices may reduce the aerodynamic loading and noise associated wind turbines, turbomachinery, and dampen flow-induced oscillations of bridges and pipelines.

AF98-208 TITLE: Neural Network Based Aerodynamic Flight Simulation

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a PC-based neural network to simulate the aerodynamic characteristics of a weapon in flight.

DESCRIPTION: The potential to develop neural networks capable of accurately and rapidly predicting the time varying aerodynamic characteristics of complex flow fields has been demonstrated. Such models offer the potential to dramatically reduce weapon system development costs. Currently, new weapon systems require extensive (and expensive) wind tunnel entries to acquire aerodynamic data across the entire spectrum of expected flight conditions. By training a properly designed neural network on judiciously selected data points representative of expected flight conditions, flight vehicle performance could be validated with a combination of wind tunnel and neural network-based simulation data. The amount of wind tunnel test time required would be significantly reduced to acquire only the representative data necessary to adequately train the neural network. Additionally, since a neural network model calculates near wind tunnel quality data virtually in real-time, a highly accurate flight profile model of a known flight vehicle geometry could be built around the neural network-based aerodynamic model. Such a flight simulator would greatly aid the development and employment of emerging weapon systems. The focus of this topic is to explore the possibilities of developing a neural network based flight simulator. The goal is a low-cost, real-time flight profile simulation model capable of operating on a PC platform.

PHASE I: Demonstrate the feasibility of a PC-based neural network aerodynamic prediction model for an existing flight vehicle.

PHASE II: The aerodynamic prediction model will be fully developed and trained to model the flight performance characteristics of an existing weapon system. The model will then be incorporated into a flight profile simulation model capable of accurately and in real-time predicting flight vehicle response to various control surface inputs, freestream environment conditions, and initial conditions.

PHASE III DUAL USE APPLICATIONS: Both private and commercial aircraft manufacturers could benefit from neural network aerodynamic prediction. The amount of expensive wind tunnel testing that is required to characterize the performance of aircraft designs would be drastically reduced. The trained aerodynamic simulation code would generate the bulk of the required data, at a fraction of the cost. Cost savings in the millions of dollars would be realized for each aircraft design configuration.

REFERENCES: Schreck, S.J., Faller, W.E., and Luttges, M.W., "Neural Network Prediction of Three-Dimensional Unsteady Separated Flow Fields", Journal of Aircraft, 1995.

AF98-209 TITLE: Terra Navigation Penetrator

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop a maneuvering architecture for a ruggedized penetrating munition.

DESCRIPTION: Global Position System (GPS) navigation is creating a new era of highly accurate weapon guidance by providing munitions with three-dimensional position and velocity information world wide, day or night, and in all weather conditions. GPS does an excellent job providing the munition navigation data required for accurate guidance to a ground based target. However, the requirement of hitting a subterranean target is increasing in importance. It is not always suitable or possible to penetrate to a chosen underground target by the natural in-ground penetrating munition trajectory. Therefore, the focus of this effort will be to leverage off current munition GPS navigation technology and develop a terra navigation system capable of maneuvering a penetrator to a target that is greater than fifty feet below the surface of the earth. This opens up some technological challenges such as ruggedized

navigation sensors capable of operating during and after ground entry, successful deployment and survivability of the terra control surfaces, subterranean navigation scheme, and the integration of navigation and control schemes with a penetrator weapon platform. The Wright Laboratory Armament Directorate is interested in receiving proposals in either the guidance or control areas for a terra navigation penetrator type munition.

PHASE I: Investigate potential navigation schemes and/or control surface technologies capable of withstanding and operating through ground penetration forces and navigating to a buried target. If the proposal is for navigation, a subterranean navigation scheme to aid a penetrator in maneuvering to an off-axis target point underground will be devised, including all algorithms and guidance laws necessary to navigate to a buried target. If the proposal is for control surface technology, Phase I will include a design trade study of various control methods including all electro-mechanical aspects of the control surface and deployment mechanism. In either case, Phase I will culminate with a final design for Phase II implementation and an integration plan outlining the various measures of merit for weapon integration.

PHASE II: Implement the Phase I design in prototype navigation software or prototype control surface hardware. The prototype will be demonstrated in either a software simulation or hardware testing sufficient to allow all integration parameters to be determined.

PHASE III DUAL USE APPLICATIONS: The technology developed in this effort could be applied to the oil/gas well drilling industry as well as the medical field. The miniature/ruggudized control surface technology could aid in drilling tip placement and location tracking. The underground navigation scheme could be used in inner-body cavity exploratory surgery. The Wright Laboratory Armament Directorate may also separately fund a follow-on Phase III effort for actual integration and testing of the navigation scheme or control scheme on a penetrator weapon.

AF98-210 TITLE: Aeroshaping Optimization Using Computational Fluid Dynamics

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Demonstrate the feasibility and efficacy of optimizing aerodynamic shapes using highly accurate aerodynamic prediction codes.

DESCRIPTION: The goal of this research effort is to explore the feasibility of combining numerical optimization with computational fluid dynamics (CFD) and to subsequently develop a highly accurate aerodynamic shape design synthesis capability. There are several technical challenges associated with this problem. For CFD solutions, there are issues of efficiency and robustness because even inviscid flow solvers can take many hours to converge on high end workstations for a single point-design solution. This is an important consideration because any general optimization algorithm will require many flow solutions to transform the original design into an optimum one. A technical challenge then is developing methods to sufficiently converge flow solutions, while at the same time not overly extending computer processing time. During the optimization process the body geometry is actually changing so that techniques to automatically regenerate grids about the body will also have to be developed. Improvements of the optimization algorithms to optimize vehicle shapes are required to ensure accuracy (that is, ensuring global minimum is found), efficiency, and compatibly with CFD flow solvers. The ability to run the code on a Silicon Graphics workstation is required. A graphical user interface should be included to enhance user friendliness of the tool.

PHASE I: Research the state-of-the-art, propose improvements, and investigate the feasibility of incorporating a general purpose three-dimensional CFD flow solver within an aeroshape optimization shell. The major issues of efficiency and robustness should be addressed. Software integration specifications should also be developed in this phase. Simple test cases should be run to demonstrate the software capability and potential.

PHASE II: Continue the development of a CFD/optimization design code. The goal is to obtain a synthesis code suitable for preliminary design of aerospace vehicles for hypersonic, supersonic, and transonic flight regimes.

PHASE III DUAL USE APPLICATIONS: The military end product resulting from this topic will be a design tool optimizing aerodynamic shapes for munition airframes using aerodynamic prediction codes. In many engineering disciplines, numerical simulations are routinely used in the design process. A CFD/optimization design tool could impact many areas in commercial aircraft design such as wing design and turbine blade design. The automotive industry could also benefit from this research if a low speed CFD solver was utilized.

REFERENCES: Landon, Mark and Yeager, Carrie, "Rapid Aero-shape Generator (RAGE)," ASC-TR-95-1000, August 1993, APTEK, Inc., Colorado Springs, CO (DTIC AD-A295635).

AF98-211 TITLE: Guidance Research

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop innovative concepts in guidance technologies for air deliverable autonomous munitions.

DESCRIPTION: The Advanced Guidance Division of the Wright Laboratory Armament Directorate seeks new and innovative ideas/concepts in several areas: electro-optical, millimeter-wave, and radio-frequency seeker technology and the components and signal processing systems used in such seekers for autonomous guided munitions. This includes, but is not limited to, (1) sources, detectors, polarization-sensing elements and systems, modulators (both single element and pixelated), pattern recognition and processing systems, and basic material and device development for accomplishing all of these, (2) polarization-sensing elements and systems for studies of the utility of such systems for target characterization and discrimination, (3) developing algorithms for use within autonomous target acquisition (ATA) applications, (4) innovative signal and image processing algorithms used, for example, in synthetic-aperture radar (SAR), millimeter-wave (MMW), imaging infrared (IIR), and laser radar (LADAR), needed to autonomously detect and recognize target signatures embedded in sensor data, (5) operations/functions associated with the ATA process involving noise elimination, detection, segmentation, feature extraction, classification, (e.g., truck vs. tank), and identification (e.g., truck A vs. truck B), (6) utilization of image algebra in the development of non-proprietary ATA algorithms. Algorithms capable of processing/fusing multi-sensor data are of particular interest. Key research areas include signal and image processing, pattern recognition/classification, image understanding, artificial neural networks, fuzzy logic, superresolution, knowledge- and model-based vision, and data fusion. Concepts must have a good dual use/commercialization potential.

PHASE I: Determine the technological or scientific merit and the feasibility of the innovative concept.

PHASE II: Produce a well defined deliverable prototype.

PHASE III DUAL USE APPLICATIONS: The military end products or processes resulting from this topic will be used to develop electro-optical, millimeter-wave, radio-frequency seeker technology, and the components and signal processing systems used in such seekers for autonomous guided munitions. A wide range of commercial products could be produced from this research. Typical applications include real-time imaging, machine vision, robotics, telemedicine, object recognition, telesurveillance, spectral medical imaging, remote sensing, laser cutting, molding and medicine. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

AF98-212 TITLE: Biological Paradigms for Autonomous Seekers

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Leverage understanding of biological vision structures and functionality to develop novel seekers.

DESCRIPTION: Life forms as well as seekers for smart munitions are required to collect space, time, and color information from the environment, process it, and make some decision. The decision may be an object detection, identification, a change of position for better tracking or acquisition, or a navigation or guidance decision. Much research aimed at understanding natural paradigms has been previously accomplished to address biomedical objectives. There have been previous successes from exploiting natural paradigms, such as neural networks, genetic algorithms, and evolutionary computation technologies. More specific applications include vision chips performing outer retinal processing in the analog domain. However, there is known information about biological information processing systems that could be leveraged for armament seeker design and development. For example, vertebrate and invertebrate vision models could be used for image-related seeker processing and models of insect sensors and movement mechanisms could be used for seeker guidance, navigation, and control functions. Related concepts useful to autonomously-guided seekers are also encouraged. While leveraging biomedical understanding, this research project should also leverage commercially available hardware and software technology to ensure maximum capability at affordable production costs.

PHASE I: Identify and justify candidate biological paradigms and the seeker technologies to be supported. The proposal should also demonstrate familiarity with applicable commercial components. During Phase I a hardware prototype system or its significant components should be developed and demonstrated as a proof of concept. Extensive simulations may be substituted if hardware implementation is either trivial or not feasible. The design of a Phase II system should be presented at the end of Phase I.

PHASE II: Develop autonomous seeker components demonstrated in Phase I. Demonstrations should be designed so that seeker implementations and commercial system applications are straightforward.

PHASE III DUAL USE APPLICATIONS: The military end product of this anticipated effort will be a seeker prototype leveraging the understanding of biological information processing structures and functionality. This technology would be used commercially in real-time imaging applications, machine vision applications, robotics, and general signal transmission, processing, and storage applications.

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4. FY97 Conventional Armament Technology Area Plan, available at www.wlmn.eglin.af.mil/public/tap/arm_tap.html

AF98-213 TITLE: Global Target-Finding Through Intelligent Agent Scene Inference

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop an Intelligent Agent to aid target acquisition.

DESCRIPTION: Current Automatic Target Recognition methodology incorporates a form of blind search. Loitering autonomous systems fly pre-programmed flight profiles while onboard sensors form digital representations of the physical world. From this representation, potential targets are segmented, classified, and identified. A target is selected based upon the classified/identified potential targets, within the sensor field-of-view, and the predefined target priority list. This method of target selection is appropriate for weapons with limited maneuverability. Weapons capable of maneuver may be better served with the addition of a high level control element (Intelligent Agent) capable of deducing possible target location and intent as well as advantageous flight profiles based on observed non-targets and mission planning data. The Intelligent Agent will not recognize targets per se, but will enhance the target-finding ability of the autonomous system. The Intelligent Agent concept provides an architecture through which mission situational awareness may be gained and exploited to enhance the overall performance of the autonomous weapon system.

PHASE I: Investigate possible artificial intelligence techniques capable of meeting the envisioned Intelligent Agent concept. An analysis of these various techniques and rationale for choosing one for the Intelligent Agent concept should lead into the development of how and where this concept will fit into the control system of an autonomous platform. This project must address mission planning data incorporation (as the knowledge base) as well as autonomously collected on-board sensor data. Metrics which characterize the performance of the Intelligent Agent in target finding are to be defined and rationalized. Successful development of a high level language (such as The Math Works Inc. MATLAB environment) Intelligent Agent, rudimentary simulation, and analysis, would complete the Phase I effort.

PHASE II: This phase should involve the software and hardware construction of the Intelligent Agent and integration into a specific simulated or real system. In any case, the system is required to possess real-time capabilities when hosted on a commercially available processor. This effort would also narrow the scope for the implementation of the Intelligent Agent concept by defining available mission planning and sensor data, and their format and data rates for a specific platform. Metrics defined in Phase I of this SBIR would be adapted for the specific test system and used to evaluate the overall performance difference between the base-line test system and the system incorporating the Intelligent Agent.

PHASE III DUAL USE APPLICATIONS: This project concerns the development of an Intelligent Agent capable of inferring possible states of the relevant universe based on a starting knowledge base (military mission planning information) and acquired sensor data during autonomous weapon system operations. This Agent is relevant to many forms of autonomous machine operations in unstructured and partially unknown environments. Current possible uses include planetary explorers (atmospheric, terrestrial, and oceanic), autonomous transportation systems, and automatic security systems.

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AF98-214 TITLE: Real-time Rendering of Translucent Volumetric Objects

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop a generalized method to model radiance of gaseous and particulate volumetric regions in real-time.

DESCRIPTION: Producing physically correct imagery in all wavelengths (ultraviolet to millimeter wave) of translucent volumetric objects at real-time frame rates is required to support hardware-in-the-loop testing of advanced seeker systems. (The primary translucent objects of interest include missile, aircraft, ground vehicle, and stationary (chemical, biological, and nuclear facilities) exhaust plumes, aircraft contrails, clouds, explosions, and vehicle dust.) Computer programs currently exist that model several of these objects both in real-time and non real-time to varying levels of approximation. However, no programs exist that model all of these objects in real-time at a fidelity and accuracy necessary to support seeker testing.

A generalized method is desired to account for the radiance emitted, absorbed, and scattered by gaseous and particulate volumetric regions in real-time. (This method must be applicable for missile, aircraft, and vehicle exhaust plumes, aircraft contrails, clouds, explosions, and vehicle dust.) The method must account for time-dependent characteristics due to variable operational states (e.g., object altitude and velocity) and environmental effects (e.g., wind speed and direction and solar position). Additionally, high frequency time-dependent spatial effects due to turbulence and diffusion must be considered.

PHASE I: Identify generic algorithms that can be applied to modeling radiance transported through translucent volumetric regions. Leveraging commercial off-the-shelf hardware and software solutions to support this task must be considered. The proof of concept must be demonstrated by producing prototype software and a preliminary validation report.

PHASE II: Develop a turn-key robust package that can be interfaced with industry commercial real-time processing packages such as PerformerTM and VEGATM. A diagnostic environment must be provided that allows users to ascertain the level of approximation based on frame-rate requirements. Additionally, the developer must be able to document the accuracy by providing a comprehensive verification and validation report.

PHASE III DUAL USE APPLICATIONS: The military purpose of this topic is to develop a generalized method to model radiance of gaseous and particulate volumetric regions in real-time at a fidelity and accuracy necessary to support seeker testing. This technology could be used in commercial visualization programs.

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AF98-215 TITLE: Compression Algorithm Designed for Target Detection

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop an algorithm for image compression designed specifically for target detection using wavelets.

DESCRIPTION: Compression of sensor data is important for transmission and storage of digital images. Conventional compression methods such as joint picture expert group (JPEG), subband coding, fractal coding methods, etc., are suited to optimizing the reconstructed output to achieve the most subjectively pleasing images possible with high fidelity reconstruction and low bit rates. In the defense industry automatic target recognition (ATR) paradigm, this is not the relevant optimization criterion. The primary requirement is the preservation of target detection and recognition performance, a concept which is somewhat new in the compression community. Conventionally, two separate processes are used, compression of the entire image and then detection, to perform the proposed work. Because of the two-stage processes, the compression algorithm is not designed so that the compressed data set is optimized for a detection scheme. For example, during the compression algorithm development stage, the engineer knows the important attributes needed to be retained for a detection application; therefore, he can incorporate that knowledge into the compression algorithm, thereby maintaining ATR relevant features while discarding the unnecessary information.

The proposed new selective compression algorithm should provide an efficient technique that takes advantage of the synergy shared between data compression and target detection. The approach developed should incorporate the design criteria for both image compression and target detection to yield an algorithm that provides high compression ratios while maintaining high levels of detection/recognition accuracy.

PHASE I: Determine which compression and detection algorithms are the best candidates to be used in the development. Task I should include evaluations of several known compression algorithms (for example: JPEGS, fractals, and wavelets) to establish an understanding of the underlying processes and the advantages for each coding technique. Theory regarding the general design of target detection algorithms (statistical models, neural nets, etc.) should be considered. The results obtained from Task I will be used to develop the new method that optimally combines both compression and detection schemes in Task II. To demonstrate the new method feasibility, a preliminary proof of concept code will be developed and implemented for this phase.

PHASE II: Serves as an algorithm development and validation phase. It demonstrates the use and performance of the new compression method developed in Phase I coupled with an appropriate detection algorithm. An algorithm development effort including coding and testing is required. The new compression algorithm should be implemented in C or C++ language and optimized for speed and performance. Testing of the new algorithm for performance on a variety of synthetic images with pertinent targets (government-provided) will be conducted to determine its level of detection accuracy. The compressed database obtained from the new method will be tested against the compressed database from a conventional method (JPEG, wavelets) for detection accuracy. Changes in the algorithm will be implemented, if needed, to improve its performance. The final code should be user friendly and well documented.

PHASE III DUAL USE APPLICATIONS: This work should lead to a new methodology for image compression algorithms which are designed specifically for target detection. This technology is a vital contribution in the area of image processing. Commercially, it can be used in numerous applications including content-based database retrieval, database archiving and searching, telemedicine, and robotics.

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AF98-216 TITLE: Compact High-Power Laser

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Design and construct a small, pulsed, high-power laser.

DESCRIPTION: High-power pulsed laser systems are generally large and not portable. Even when the laser head is small, large cooling systems and solid-state pump sources are required to operate the laser. Small, compact systems exist, but that size comes at the expense of power. Microchip lasers offer very high beam quality in small packages; however, their power is measured in the tens of milliwatts range. Direct detection laser radar systems require high-power pulsed lasers, but an effective military system must be portable, reliable, and maintainable. Innovative designs for a rugged, compact laser that can deliver about 10 watts average power, with pulse widths less than 10 nanosecond at 20-50 kHz is the goal of this topic. This laser should run self-contained with an ultimate volume goal for the system including electronics and cooling on the order of 200 cubic inches. To make pointing of the LADAR system manageable, the laser head should be light weight with a size goal of about 6 cubic inches. Systems with a frequency and power stability from pulse to pulse of about 98 percent are desirable. Likewise, jitter between pulses (both temporal and intensity) should be very low. A high beam quality allows much greater spatial resolution on the target with fewer optics, thus a nearly diffraction limited beam is most suited for the LADAR application (M2 < 1.2). There is a special interest for eye-safe wavelengths at 1.5 mm or greater, but systems with wavelengths between 1.0 and 1.5 mm will also be considered.

PHASE I: Investigate a design for the laser. The lasing medium, cavity design, damage thresholds, stability, beam quality, and cooling mechanisms (if required) should all be addressed in Phase I.

PHASE II: Construct and package the laser using the design and materials investigated in Phase I.

PHASE III DUAL USE APPLICATIONS: The development of a compact high-powered pulsed laser systems described above would benefit both commercial, industry, and military applications. The purpose of this topic is to develop a laser system that will meet the stringent requirements; space, power, reliability, and survivability, for use in a LADAR application. Improvements upon current laser systems would also affect commercial application of remote sensing, LIDAR (airborne pollution detection, hazardous spill evaluation, etc.), laser cutting and welding, and medicine.

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AF98-217 TITLE: Very Low Cost Passive Millimeter-wave Imaging

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop extremely low-cost passive MMW imaging sensor.

DESCRIPTION: For the past six years the Wright Laboratory Armament Directorate (WL/MN) has been investigating the potential of millimeter-wave radiometric (passive MMW) imaging for smart tactical autonomous guidance. Passive millimeter-wave imaging (PMWI) has significant all-weather advantages over infrared, LADAR, and visual sensors. PMWI can be performed day or night, through dense fog, smoke, and other opaque obscurants that would blind any optical wavelength based sensor. Additionally, millimeter-waves have remarkable penetrating power. Metal and plastic (explosive) objects can be observed when hidden from view beneath nets, tents, camouflage, poly-propolene, leather, hard board, and even certain thicknesses of ceramic materials such as sheet rock. This latter property has made PMWI a prime candidate for airport security, and weapon or explosive material detection. Prior to the investigations performed by WL/MN, PMWI development was being driven by the need to assist large commercial aircraft to make safe landings under adverse, (particularly foggy) weather conditions. Since autonomous landing represents a rather large potential for cost savings (for example overcoming the necessity to shut down a major airport), the cost of the sensor was not a restrictive issue. However, there have been dozens of identified applications, ranging from fire fighting to in-land waterway navigation, that could be greatly enhanced by a cost effective PMWI sensor. These more cost conscious applications typically do not require high-speed, moving picture rate imaging, but only one or fewer frames per second. This greatly reduced speed-of-imaging requirement opens up the possibility of building extremely low cost PMWI sensors. It is believed that greater than a 100 to 1 reduction in cost is possible; a reduction from more than $250,000 per unit to less than $10,000 for most applications. Because the potential commercial market for PMWI sensor is large, unit costs should plummet. With few exceptions, these commercial sensors have direct military application. Since reliability constraints for commercial application will be equally as stringent, the military community could employ commercial off-the-shelf (COTS) systems directly with no need for modification or upgrade of capability.

PHASE I: Develop an innovative approach and preliminary design for very low-cost passive millimeter-wave imaging with the widest potential for commercial application.

PHASE II: Produce and demonstrate a prototype of the selected design under realistic military and commercial application conditions.

PHASE III DUAL USE APPLICATIONS: The end product for this effort will be a millimeter-wave radiometric (passive MMW) imaging sensor used for a smart tactical autonomous guidance kit for missiles. Personnel from the Armament Directorate have briefed the potential of PMWI technology at several conferences and workshops where Dual-Use was a key item of interest. Knowing the all-weather and material penetrating capabilities of PMWI, most military and commercial applications are readily perceived. There is also direct application to fire-fighting. There are over 100,000 brush and timber fires in the US each year with more than 30% of them greater than 10 acres in extent. An airborne PMWI system could peer down through flames and dense smoke to precisely locate the source or hot spots to which fire suppressants are to be applied. A PMWI system would permit the delivery aircraft to fly through the haze and dense smoke with no fear of collision with metal towers or cables strung between them. Metal objects are extremely bright in the passive MMW imaging region. Fighting building fires, on the other hand, could be greatly aided by viewing internal hot spots from outside the building.

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AF98-218 TITLE: Ordnance Research

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions ordnance packages.

DESCRIPTION: New and innovative ideas/concepts and analytical methodologies are needed in the area of air delivered non-nuclear munitions, that have a dual use/commercialization potential. Military products include bombs; penetrators; submunitions; warheads; projectiles; fuzes (including safe and arm devices); explosives/energetic materials; time delayed, self-degrading explosives; genetic engineering of molecular explosives; polymer binders for shock survivable explosives; fiber optics; solid state inertial components; exterior ballistics; test technology; modeling and simulation resources and techniques; and conventional weapon environmental demilitarization and disposal techniques. Examples of desired research are target detection sensors for deeply buried targets; warhead initiation; self-forging fragment warheads; shaped charges; reactive fragment warheads; hard-target weapon/penetration technology to include terradynamic steering/braking and energetic materials, low velocity deep earth penetrators. Concepts and methodologies for defeating and neutralizing chemical and biological agents during production, storage and employment in weapons of mass destruction are desired. Technologies for denying enemy access to weapons of mass destruction are also of interest.

PHASE I: Determine the technological or scientific merit and feasibility of the concept.

PHASE II: Provide a deliverable prototype.

PHASE III DUAL USE APPLICATIONS: The military end products or processes resulting from this topic will be used to develop advanced warheads, fuze systems and energetic materials for munitions. A wide range of commercial products could be produced from this research. Typical products include propellants, initiators, gas generators, high strength steels and other metallic materials, low cost sensors/detectors, and environmentally compatible recycling processes. Each proposal submitted under this general topic should have an associated dual-use commercial application. Phase II will require a complete commercialization plan.

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AF98-219 TITLE: Media Detection and Identification Sensor

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop a sensor capable of determining the type of medium surrounding a penetrating weapon.

DESCRIPTION: Their exists a need for a simple, compact device capable of sensing the media that immediately surrounds it. For example, a drilling rig capable of determining if it has run into water, air, or oil pockets. The Air Force has an interest in developing a sensor capable of identifying when a penetrating weapon has entered an air void, soil, or target material. The identification must be made as soon as possible (< .001) after the projectile enters the media (i.e., air). The sensor would use a non-inertial device to discriminate between the different types of media. Such a sensor system would be expected to function independently of any components within the weapon system with the exception of electrical power.

PHASE I: This phase should include design, analysis, and modeling of the proposed sensor. Proof of principle laboratory experiments are desirable. Phase I should include optimization of the sensor parameters.

PHASE II: Optimize the design developed during Phase I and fabricate the sensor system to meet the desired goals for size and high g level shock loading to weaponize the system for field tests.

PHASE III DUAL USE APPLICATIONS: The end product of this effort will be a sensor capable of identifying when a penetrating weapon has entered an air void, soil, or target material. This type of sensor could have a variety of applications in mining, civil

engineering, environmental engineering, transportation, and criminology involving the detection and discrimination of different types of materials.

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AF98-220 TITLE: Shock Hardened Timer Base Research

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop a time base capable of providing an accurate timing device for penetrating weapons.

DESCRIPTION: To allow for more rugged, shock hardened communications and global position system equipment, a timing device capable of withstanding high G loads is needed. Penetrating weapons and other high shock applications have historically utilized RC (resistor/capacitor) oscillators to establish a time base for weapon functions. Although RC oscillators are not very accurate (± 5%) they have proved the most reliable mechanisms under high shock. Quartz crystals are used in some gun launched applications, but existing designs have proved marginal at higher direct loads and off axis acceleration loads. Due to the increased emphasis on precision weapon response after hard target impact, it is imperative that significantly improved (<±0.002%) timer bases be developed. Typical penetrating weapon shock loads are up to 100,000 G at frequencies of 100kHz. Additional important characteristics include stability over the standard temperature range (-65 F - +165 F) and low electrical power consumption.

PHASE I: This phase should include design, analysis, and laboratory bench testing of the proposed device or components.

PHASE II: This phase should include the final design, fabrication, packaging, and testing in the munition environment.

PHASE III DUAL USE APPLICATIONS: The end product of this effort will be a time base capable of providing an accurate timing device for penetrating weapons. This type of device would be highly marketable for portable communication devices such as cellular phones, pagers, and mobile navigation receivers.

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AF98-221 TITLE: Nano-particles: Novel Coating Methods and Modeling Reactions with Liquid/Solid Oxidizers

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Design and apply passivating, polymer/monomer coatings for nano-scale metallic particles.

DESCRIPTION: The Wright Laboratory Armament Directorate is interested in receiving proposals in the area of coating metallic nano-particles or in the area of modeling metallic nano-particle reactions. Nano-scale (10-100 nanometer (nm) diameter) metallic particles are used in various material systems such as explosive ingredients. Such particles can oxidize before use, reducing or eliminating their usefulness. It is desirable to create a layer on each nano-particle's surface that will significantly reduce or eliminate particle oxidation. Various oxidizer-diffusion-limiting coatings, that are currently in use, are brittle and tend to crack during handling. Further, it is expected that monomer/polymer particle coatings can be used to stabilize diffusion-limiting coatings. The coating method(s) designed under this effort should not agglomerate the nano-particles. Proposed coating techniques and methods must be suitable for scale-up to bulk material production. Proposals should note the ranges of applicable materials. Such nano-particles can react violently (burn) when exposed to high strength oxidizers. Analytical and numerical modeling to predict the complete reaction dynamics between candidate metallic nano-particles and oxidizers is also sought.

PHASE I: Develop a detailed description, analysis, and method(s) for producing and coating nano-scale particles. Produce a sample of nano-particles (50+ grams), with conventional metal-oxide coatings or novel coatings, for demonstration of nano-particle production proficiency. Complete a non-dimensional analysis and a detailed model of the nano-particle/ oxidizer

interaction. Solve the detailed model analytically and determine the solution's applicability range.

PHASE II: Develop a working prototype of the nano-particle production and coating method and implement a proof-of-concept demonstration. A sample of nano-particles (100+ grams), with novel coatings, will be produced for analysis to demonstrate production concept. Perform system analysis to determine the performance benefits of the technology. Show a clear path to bulk production capacities in excess of 1 kg per hour. Complete a detailed numerical model of the reaction event. The numerical model will execute for less than 24 hours on a personal computer. It will allow user-defined initial and boundary conditions with spatially varying data. The numerical model will be demonstrated for candidate nano-particle/oxidizer systems and initial/boundary conditions. Numerical data will be compared with experimental data.

PHASE III DUAL USE APPLICATIONS: The military end products and processes resulting from this topic will be a passivating, polymer/monomer coatings for nano-scale metallic particles used for warheads. Nano-particles may have use in energy storage systems, plasma cutting torches for use above and below water, electronic contact surface coating, alternative solid engine/turbine fuels, lead-free ammunition primers, etc.

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AF98-222 TITLE: Modeling and Data Acquisition Research

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop advanced capabilities to model and acquire data for highly dynamic, short duration events.

DESCRIPTION: Innovative concepts are sought for development of:

(a) Simulation tools to enable simulation of explosive events and devices using more physics-based modeling methodologies capable of shorter computer run times that can compete favorably with the fast running current empirical models.

(b) Data acquisition devices capable of functioning in the harsh environment of an explosive event while measuring and/or recording data at the high rates and resolution needed to develop and validate models and simulations of the very fast and transient high explosive events. Pressure, temperature, and image data are sought to characterize the physical phenomenology occurring within explosive events, as well as material deformation, deformation rates, failure modes, and fragmentation physical parameters. Currently, the most common data acquired from explosive events is obtained from electro-mechanical sensors and high-speed film cameras that exhibit relatively slow response rates and very limited ability to time sequence the sensor function with the functional dynamics of the transient event. Typically, these sensors could not be placed closer than about 100 feet or more from the explosive item. Needed are fast response, non-mechanical electronic/optical devices that can provide accurate measurements of explosive reaction zone tempera-tures and blast pressures, metal strain and deformation during casing breakup, at or within inches of the explosive.

(c) Models which enable prediction of the functional relationship of fire and/or blast effects on fixed structures as related to type of source explosive.

(d) Models to optimize capability for evaluating performance of explosive device applications and system simulations.

PHASE I: This phase will include a technical evaluation of the concept or methodology, a demonstration of proof of principal, and a description of technical approach, alternative approaches and associated risk factors.

PHASE II: During this phase, the development and fabrication or formulation will be conducted to the extent necessary to provide a product that can demonstrate the proposed capability.

PHASE III DUAL USE APPLICATIONS: The military end products and processes resulting from this topic will be advanced simulation tools and sensors to acquire or process data for highly dynamic, short duration events in ordnance testing and evaluation. Explosive events and devices are common in the commercial sector. Methods of measuring physical effects and performance would be of great value in reducing developmental and unit cost. Simulations of effects would reduce test costs and provide greater capability for safety officials and insurance underwriters to assess associated hazards. Improved simulation models using advanced analytical methodologies would be of value to a wide variety of commercial activities requiring analysis of the effectiveness of operations or product quality or performance. These developments could benefit commercial building demolition, safety-related assessments, auto safety research, explosives research, mining, drilling, and a wide range of product analysis and evaluation activities.

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AF98-223 TITLE: Ground-Fixed Target Vulnerability Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Modeling and Simulation (M&S)

OBJECTIVE: Develop models for damage mechanism hardened and non-hardened structures.

DESCRIPTION: The Wright Laboratory Armament Directorate is interested in identifying, developing, and integrating physics-based models capable of accurately simulating the effects of conventional weapons on hardened and non-hardened structures. The technical challenge is to be able to predict the environments produced by conventional weapons and the structural and functional response of the structure to these environments in a manner which permits both a high-fidelity assessment of the weapon-target interaction as well as a rapid estimation of the overall effectiveness of the weapon system. Of interest are physical and/or phenomenological models to include (but not limited to) the following:

Material behavior of geologic and geologically derived media at high strain rates.
Penetration mechanics in the high- and hyper-velocity regimes.
Response of multi-layered media to embedded detonations.
Structural and functional response of tunnels to conventional weapon attack.
Novel mechanisms for concrete destruction.
Chemical interaction between shaped-charge liners and geologic and geologically derived media.

PHASE I: The research will demonstrate the feasibility and usefulness of the proposed modeling approach through a limited proof-of-concept study.

PHASE II: The research and methods demonstrated in Phase I will be developed to produce models suitable for assessing weapon-target interactions.

PHASE III DUAL USE APPLICATIONS: This project involves an area of research of great interest to both the military and industrial community. The military end products and processes resulting from this topic will be models capable of accurately simulating the effects of conventional weapons on hardened and non-hardened structures. Advances in this field would have impact on the industrial community's ability to assess the effects of accidental explosions or sabotage in mines, storage facilities, and conventional urban structures.

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AF98-224 TITLE: High Repetition Rate/Long Pulse Photographic Laser Source

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop methods to investigate high repetition rate and long pulse laser sources for imaging of extremely dynamic events.

DESCRIPTION: In our effort to move from empirical based to physics based models, high resolution, high temporal rate data is needed from dynamic experiments. Time resolved spatial and temporal data of complex mechanical systems under load and impact is necessary to verify and validate these new models and simulations. One deficient area is high resolution image data for fragment/target material dynamics and characterization. This effort is to develop new illumination sources for application to digital high speed devices. Recent work in high speed and ultra high speed photography of shock and explosive events using Ruby, YAG, CuV and other lasers, has shown that use of laser illumination can greatly improve image quality and penetration of shock ionization of the surrounding air. Applications include combustion studies, particle field imaging velocimetry, stereo photography, and holography. Current laser technology can only provide 2 to 4 pulses at the Joule or higher output level with a 15 to 30 nanosecond (nsec) pulse. Typical high speed photographic or holographic experiments are up to 1 millisecond long and exposures are in the 1 nanosecond to 1 microsecond (msec) duration. For use with new holographic and electronic ultrahigh speed cameras, higher power visible lasers with either very short (1-2 nsec) pulses at high repetition frequency (1 megahertz) for 250 to 500 pulses, or a higher power level giant pulse for several hundred microseconds to 100 milliseconds is needed. Typical large rod ruby lasers have about a 800 usec maximum extraction time available and this limits experimental data collection based on distance traveled by the test object. Multiple rods or other configurations may be needed to extend the available test duration. For light-in-flight applications the shorter pulse will allow range gated imagery to see through shock and combustion waves. Methods of both spoiling and enhancing coherence for interferometric or photographic applications should be incorporated.

PHASE I: Perform a design trade and proof of principle experiments using state of the art pulsed power sources and laser technology. Analysis should include measurements of contrast ratio, resolution, dynamic range, spectral purity and energy. Multiple exposure for up to 8 pulses with fast repetition performance should also be documented.

PHASE II: The system will be used to experimentally determine best combination of illumination, digital electronically/electro-optically shuttered sensors, and data processing to provide analytical data imagery from dynamic events. Tests will be conducted to demonstrate the illumination system with digital camera and/or holographic cameras at the Advanced Warhead Evaluation Facility or Ballistic Experiment Facility at Eglin AFB, FL.

PHASE III DUAL USE APPLICATIONS: The military end products resulting from this topic will be a high repetition rate and long pulse laser sources for imaging of extremely dynamic events during ordnance/munitions testing. High Speed Laser systems have wide application in biomedical imaging, commercial non-destructive testing of structures, aerospace testing of engines, wind tunnel flow, and meteorological applications. Military applications include use in range gated imaging systems for underwater mine and obstruction detection as well as for bathymetry of navigation channels. This technology will also find major applications in fuel combustion research, large structure testing, and earthquake research.

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AF98-225 TITLE: Imaging Analysis System for Dynamic Events

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop "Light-In-Flight" techniques to acquire, analyze, and display fragments from extremely dynamic events.

DESCRIPTION: Models are being developed to design and analyze the effects of energetic explosives and other materials from a physics based approach versus the current empirical based approach. Very accurate spatial and temporal data is required to develop and validate these models with sub- and full-scale experiments. This effort is to research "Light-In-Flight" techniques to acquire high resolution visible, laser, or X-ray images of warheads, projectiles, explosives, and subsequent target fragmentation and debris. This requirement is based on the need for accurate analysis of solid particle, molten metal, combustion/shock waves, and liquid phase droplets during energetic events. Prior work has shown that gated film imagery can provide high resolution imagery of extremely dynamic warhead events. The use of laser illumination can overpower most impact flash and warhead combustion processes. This research will evaluate new image sensors and electro-optic shutter technology that can shutter the exposure time to less than one nanosecond (30cm). The objective of this effort is to develop a one foot or less range resolution, 60 line pair/millimeter spatial resolution imaging system that can survive in the rugged blast/shock/temperature environment of conventional warhead test arenas. The capability will be compatible with Ruby, YAG, CuV and other lasers and incorporate low lag, high output X-ray scintillators for replacing film in flash X-ray work. The research encompasses field/lab sensor and optics characterization and orthocorrection of interior and exterior distortions. The optical design shall include use of wide field of view fast optics for close work (1-5 meters) as well as long stand-off (5-100 meter) telephoto optics. Experiments to define/analyze light output from explosive and penetration experiments will be performed to define senser design. With higher resolution and dynamic range charge coupled devices (CCDs) and image intensifiers, initial 2 thousand by 2 thousand and later 4 thousand by 4 thousand pixel images should be achievable that will equal or surpass the resolutional film based systems. Multiple exposure techniques for binning images and tracking particles should also be achievable. Images should be registerable both to the test arena (chamber or field) and registerable/mosaicable to themselves and third source digitized imagery. Parameters to be extracted include surface motion/deformation, fragment shape/volume/type, vector motion quantities including velocity, acceleration, and rotational moments, shock wave density and motion, volume change and image to image correlation of data. Wireframe model extraction from single and multiple images should be incorporated. Timing for all sensors is needed relative to common triggers or event detectors: triggering delays and offsets must be characterized.

PHASE I: Conduct a design trade and proof of principle experiments with simulated configuration and three dimensional measurement/wireframe extraction at the Advanced Warhead Experimental Facility or Ballistics Experimental Facility at Eglin AFB, FL.

PHASE II: Experimentally determine best combination of illumination, sensors, data processing, display, and hardcopy techniques to provide analytical imagery of warhead data. The Phase II program will develop multisensor imaging systems with illumination and demonstrate performance in severe blast environments. Remote operation and calibration from bunker settings will permit up close coverage of the explosive or impact event.

PHASE III DUAL USE APPLICATIONS: The military end products resulting from this topic will be "Light-In-Flight" techniques to acquire high resolution visible, laser, or X-ray images of warheads, projectiles, explosives, and subsequent target fragmentation and debris during ordnance/munitions testing. The successful completion of the Phase II effort should produce systems for use in the commercial blasting, mining, automotive, aerospace, and combustion research communities. The resolution of the sensor system to be demonstrated will also have high application in the medical imaging environment. The compatiblity with X-ray, visible, and laser light sources will provide direct input into the commercial printing, textile and metal manufacturing industrial community.

REFERENCES:

1. Shaw, L.L., Muelder, S.A, et. al., "Electro-Optic Frame Photography with Pulsed Ruby Illumination," 20th International Congress on High Speed Photography and Photonics, Victoria, B.C., Sept 92, SPIE.
2. Baum, B.W., Shaw, L.L., et. al., "Liner Collapse and Early Jet Formation in a Shaped Charge," Proc. Ballistics `93, 14 Intl. Symp., Vol 2, p13-22 (1993).
3. Honour, Joseph, "Electronic Camera Systems Take the Measure of High Speed Events," Laser Focus World, Oct 94.
4. Held, Manfredd, "Detonation Studies with a Ballistic Range Camera," Propellants, Explosives, Pyrotechnics 20, 337-344 (1995).
5. Hogan, Daniel, "Applications of copper vapor laser lighting to high speed motion analysis," SPIE Vol. 1346, Ultrahigh and High Speed Photography, Videography, Photonics, and Velocimetry `90. July 1990.

AF98-226 TITLE: Predictive Activity-based Cost Modeling Agent Network

CATEGORY: EXPLORATORY DEVELOPMENT; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop a tool for Activity-Based Cost modeling (ABC) based on autonomous agents to improve complex maufacturing system cost forecasting.

DESCRIPTION: Activity-based costing has become popular among both financial and operational managers as a mechanism for

understanding the sources of manufacturing related costs. ABC tracks costs based on the activities that generate them, and not on the traditional categories of labor, materials, overhead, etc.. Effective use of ABC allows heightened visibility into the true cost drivers associated with a manufacturing enterprise. The ability to model and forecast costs within the context of an ABC accounting system has potential to allow manufacturers to more efficiently manage their resources and be more responsive in an ever changing market environment. Currently, ABC is used to track costs as they occur and not to model or forecast them. With the advent of powerful, inexpensive computing and object oriented programming, the ability to model and simulate complex systems using collections of simple, autonomous software agents operating in parallel has become feasible. The purpose of this effort is to explore the use of autonomous software agents to represent various manufacturing cost activities defined within an existing ABC system, and use this modeling capability to effectively forecast manufacturing costs.

PHASE I: Provide a detailed analysis of a subset of activity based cost activities, and description, analysis and initial coding of software agents representing these activities and the relationships between them. Phase I will culminate with the initial feasibility demonstration of a ABC cost forecasting tool based on Autonomous Agents.

PHASE II: Focus on the continued development, refinement, demonstration, implementation, and commercialization of activity based cost forecasting software based on autonomous agents. The product of the Phase II effort will be the release of a beta version software modeling tool based on appropriate generic ABC activities.

PHASE III DUAL USE APPLICATIONS: Manufacturing cost prediction is essential to both commercial and defense companies. This tool will be used to enable more effective cost prediction by all companies. This will increase the affordability of complex commercial and defense systems by allowing integrated design teams to compare total system costs and determine exactly where they can most impact product cost.

REFERENCES:
1. Roberts, M. W., and K. J. Silvester, "Why ABC Failed and How It Might Yet Succeed," RPM Group and Rensselaer Polytechnic published in the Journal of Cost Management, Winter 1996.
2. Cohen, P.R., M.L. Greenberg, D. M. Hart, and A.E. Howe, "Trial by Fire: Understanding the Design Requirements for Agents in Complex Environments," AI Magazine 10:3 (Fall) 34-48.

AF98-227 TITLE: Solid Freeform Fabrication

CATEGORY: BASIC RESEARCH; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop solid freeform fabrication techniques that reduce weight and increase stiffness in aircraft, space, and missile hardware.

DESCRIPTION: Lighter and stronger structures are required to help create vehicles which can perform better, accelerate faster, carry a larger capacity, or achieve greater range. Plastic structures are severely limited in applications requiring high temperatures and high stiffness with no creeping under load. Composite structures have shown slightly more promise in heat resistance and are much better in absolute strength. Unfortunately, the best performing composites are very expensive and difficult to process. To be useful, a material must be cut, shaped, and joined to form a useful structure. All three of these processes pose significant problems to composites, especially the joining aspect. Ceramics have the heat tolerance and the compressive strength, but they are far too brittle to be used as a structural material in most applications. Metals are strong and heat resistant, but they are heavy. Solid Freeform Fabrication (SFF) is a process that will allow designers to look beyond the normal paradigms that currently limit creativity due to conventional monolithic materials.

PHASE I: Demonstrate feasibility of the SFF process for manufacturing high performance structures for aerospace and commercial components. Demonstrate the effectiveness of SFF compared to conventional materials through the manufacture of prototype components in titanium, stainless steel, and superalloy. These prototype components will be functional, 3-D structures similar in size to a missile fin core. The components for the feasibility demonstration will be selected to demonstrate adequate complexity and performance requirements.

PHASE II: Build upon the Phase I work to develop additional production capability for the SFF process that will open opportunities for more complex 3-D structures such as structural arms for satellites or wing skins. A goal of .005 inch tolerance will be demonstrated. The Phase II effort may include a prototype system delivery at an Air Logistics Center (or other DOD selected site) along with a performance demonstration. System operator training and system qualification would also be desired.

PHASE III DUAL USE APPLICATIONS: Lightweight structures for satellites, solar panel arrays, Space Shuttle parts, high stiffness components for coordinate measuring machines, machine tool structures for high speed machining applications, aircraft wing components, missile components, rocket components, and various recreational equipment are all potential applications for such a

technology.

REFERENCE: Bourell, D.L. et. al., Solid Freeform Fabrication, Symposium Proceedings, September 1996, Texas University at Austin Dept of Mechanical Engineering, ADA318152

AF98-228 TITLE: Remote Field Eddy Current Techniques for Structural Damage Detection in Aging Aircraft

CATEGORY: BASIC RESEARCH; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop new, innovative, and more accurate methods of nondestructive inspection of aging aircraft structures.

DESCRIPTION: Conventional eddy current methods have enjoyed some success in detecting and characterizing hidden cracks and corrosion damage in multilayer metal structures such as in aircraft. Attempts to improve sensitivity include active methods for canceling the influence of factors that contribute to loss of sensitivity, and shielding arrangements to improve the response to defects in the second layer. Other methods exploit recent developments in sensor technologies that allow measurements of very low field values or utilize harmonically rich excitation sources to increase the information content in the signal. An alternative approach using the Remote Field (Eddy Current) Effect may offer higher levels of sensitivity. The remote field method, currently used to inspect thick ferromagnetic tubes, offers equal sensitivity to defects on the inner and outer surface of the tube. Recent work in the area has shown that the phenomenon can possibly be utilized to inspect flat metallic plates. This could be extended to inspection of aircraft structures.

PHASE I: Develop and demonstrate the feasibility of the remote field method for finding defects, representative of those of interest to the Air Force in the aging aircraft, on flat, and nearly flat multilayer plates which represent various aircraft structure.

PHASE II: Assess, report, and improve upon the sensitivity of the method until it is ready for application on aircraft structure. After sensitivity assessment and improvements have been demonstrated, the contractor will commercialize the remote field method and develop the technique for inspecting an aging Air Force aircraft. A prototype system demonstrating the effectiveness of the method for characterizing hidden cracks and flaws in aircraft, such as the C-135, will be delivered. Evaluation of the system will include assessment of its probability of detection and sensitivity relative to technologies in current use. A commercialization plan will also be developed and implemented to apply this technology for military and commercial use for potential Phase III applications.

PHASE III DUAL USE APPLICATIONS: This technology will have immediate application for inspections of any aircraft, commercial or military.

REFERENCES:
1. Y.S. Sun et. al., A Remote Field Eddy Current EDT Probe for Inspection of Metallic Plates, Materials Evaluation, 54 4 (1996) 510-512.
2. Y.S. Sun et. al., Inspection of Metallic Plates Using a Novel Remote Field Eddy Current NDT Probe, Review of Progress in Quantitative NDE, Vol. 15A, Plenum Press, New York, 1996, 1137-1144.

AF98-229 TITLE: Affordable Plastic Patterns for Precision Investment Casting

CATEGORY: BASIC RESEARCH; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develope an affordable injectable plastic for pattern making of investment cast jet engine components.

DESCRIPTION: Precision investment castings of complex jet engine components begin with the quality of the pattern. Both wax and plastic are used in the pattern making process; both have advantages and disadvantages. The advantages associated with plastic include excellent surface finish, dimensional accuracy, and durability which makes handling easier. The disadvantages associated with plastic include its low viscosity making the filling of large dies with small passages difficult. Often, multiple injection ports and external heating are necessary to assist in completely filling the die. These methods add cost to the dies and to the pattern making process. The developed material/process must have plastic that has good flow characteristics at injection temperature yet stable and dimensionally accurate for precision investment cast components. Once the pattern is formed, it is sometimes difficult, if not impossible, to remove the pattern from the die without damage. Post injection properties of the plastic should be considered so that the plastic is dimensionally stable, easy to remove from the die, has good handling characteristics, and has good "burn-out" properties

during the investment casting process. The need exists to develop innovative low cost injectable plastics for precision investment cast jet engine components such as airfoils and other structural parts.

PHASE I: Demonstrate feasibility of the new process with the improved plastic material. This Phase should include the use of analytical tools such as simulation and modeling to predict the flow characteristics of the selected plastic into dies of varied shapes, sizes, and complexity. Emphasis should be placed on an affordable approach to minimize the cost of the die as well as the pattern making process. Although not required, it is strongly recommended that the vendor work with an investment casting company during Phase I. This Phase should also include a preliminary assessment of the anticipated cost savings/avoidance of the new plastic composition.

PHASE II: Further develop and commercialize the technology developed in Phase I. The new plastic will be demonstrated on an actual investment cast component. This will include a DOD application and preferably a commercial application as well. In this Phase, the vendor will be encouraged to work with an investment casting company to introduce and commercialize the new plastic in production.

PHASE III DUAL USE APPLICATIONS: Precision investment cast components are in widespread use throughout the commercial sector as well as in defense. Examples are: automobile components, medical implants, land based power generation units, as well as military and commercial jet engine components. This technology would provide lower cost and higher quality components in all of these applications.

AF98-230 TITLE: STEP (Standard for the Exchange of Product data/International Standards Organization 10303) Utilization Tools

CATEGORY: EXPLORATORY DEVELOPMENT; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop a commercially viable software tool that allows users to confidently transfer and share STEP files and models.

DESCRIPTION: A toolset for the implementation and utilization of the STEP standard is needed for broad based acceptance. This tool set will be targeted for use by all tiers of the supplier chain to facilitate unambiguous computer interpretation of design, analysis, and "build-to" engineering data packages by users of computer assisted tools for design, manufacturing, and engineering systems (CAX). The STEP toolset should support all major computer aided system translation requirements for wireframe through solid geometry, dimensioning and tolerancing data, analysis data, configuration management data, technical notes, technical specifications associated with design re-use, and part manufacture. The toolset is intended to allow end-users to confidently exchange computer interpretable engineering data without requiring those users to be conversant in the various technical parts of STEP. Also needed is the capability to readily establish a sharing environment for this engineering data between the various engineering disciplines. The tools will be built with a plan to update them as vendors update CAD software versions and as the STEP International Standard is updated. To ensure long term usability of these tools, Draft International Standard (DIS) parts are considered equivalent to International Standard (IS) parts for the purposes of this toolset development.

PHASE I: This Phase will result in the feasibility, technical design and proof of design for the software tools with end-user validation to ensure both ease of use and marketability.

PHASE II: The end product will be software tools with associated CAX and databases that are ready for the commercial market. These tools will run on hardware and operating system platforms representative of a major cross section of the target users.

PHASE III DUAL USE APPLICATIONS: The tools developed under this topic will be needed by large and small companies (defense and commercial) alike to be able to facilitate unambiguous transfer and manipulation of data between companies using STEP files.

REFERENCES: Libes, Don. The NIST EXPRESS Toolkit: Updating Existing Applications, National Institute of Standards and Technology, Gathersburg, MD, 1993. (DTIC # ADA315164)

AF98-231 TITLE: Weapon Systems Integrated Cost Model (WS-ICM)

CATEGORY: EXPLORATORY DEVELOPMENT; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop a weapon systems cost methodology for predictive decision weapon system cost analysis and support.

DESCRIPTION: The Air Force Manufacturing Technology Directorate, in conjunction with the F-22 System Program Office, is interested in the establishment of a methodology that supports weapon systems production management considering cost as an independent variable throughout the total life cycle. The core of this methodology must be generic weapon systems based cost models, tailorable and flexible enough to be accessed by tools and techniques used by industry. A WS-ICM framework of integrated cost architectures will be developed for major cost categories of a weapon system by control level, within and among prime and subcontractors. The WS-ICM and its component cost architectures must be designed, constructed, populated, validated and demonstrated to cost experts and program managers from across industry and government. Extensive consideration must be given to building on standards based approaches with compatible historical data interfaces enabling use (for example) of R&D, mods, spares, sustainment, prior best business practices, infrastructure, labor, learning curve data and realization cost factors, etc.. Each offeror will create a conceptual WS-ICM framework design during Phase I from which to launch detailed work on the selected specific cost category (i.e. the life-cycle Cost Estimating Model (CEM) or the Operational and Support Model (OSM)). A Production Cost Model (PCM) is currently being developed for demonstration and will be shared for integration with the contracted offerors. In the integrated WS-ICM demonstration, containing models produced by different organizations, the user must see a single and consistent view of the data, while being networked, using dissimilar computers, geographically separated, and operating in a secured (as required) repository mutually available for use by Government and industry teams supporting WS-ICM and individual WS Cost models. The F-22 SPO will participate in the technical evaluation and reviews in all phases of this project with anticipation of potential use of high quality successful automated results.

TASK SELECTION: The offeror will select TASK A or B to focus their proposal based on the above requirements. An offeror may submit separate proposals to both tasks.

TASK A: The offeror will develop a conceptual WS-ICM model and its first three levels of decomposition giving context to the CEM and OSM and other major cost components, then select the life-cycle CEM and extend that selection three more levels. The six levels of WS-ICM model with the CEM as an emphasis must be included in the offeror's proposal to specifically develop the work described above (in the WS-ICM description) but targeted for the detailing of the CEM component of the WS-ICM. The WS-ICM graphic and proposal text will demonstrate the offeror's knowledge, abstract understanding, issues and strategic approach to driving down to the lowest operational cost level in this target environment.

TASK B: The offeror will develop a conceptual WS-ICM model and its first three levels of decomposition giving context to the OSM and CEM and other major cost components then select the OSM and extend that selection three more levels. The six levels of WS-ICM model with the OSM as an emphasis must be included in the offeror's proposal to specifically develop the work described above (in the WS-ICM description) but targeted for the detailing of the OSM component of the WS-ICM of the WS-ICM. The WS-ICM graphic and proposal text will demonstrate the offeror's knowledge, abstract understanding, issues and strategic approach to driving down to the lowest operational cost level in this target environment.

PHASE I: Phase I of this effort will consist of requirements definition and analysis, establishment of a WS-ICM framework, identifying cost categories, architectures and their interfaces, prioritization list of cost categories to be developed for the WS-ICM methodology, review by a Technical Review Board (TRB) of Government, industry, and academia, design of cost models, loading data, identify Analytical Tools (ATs), report and screen designs, determine the impact of effectivity data, develop the decision trees and data for CEM and OSM cost models. The offeror should select Alpha sites early (at least one government) and work with them to develop and demonstrate a WS-ICM prototype validating the concept after importing the PCM and integrating it with the initial CEM and OSM modules of the WS-ICM. The demonstration must show the importance and influences of realtionships on costs across business domains. A prior and post demonstration survey and analysis report will determine the value to users and follow on direction for the development of the WS-ICM product.

PHASE II: The effort will continue development of the CEM and OSM models and create the decision trees and interfaces for integration into the WS-ICM. The TRB members must review and agree that the design will be useful to them prior to WS-ICM construction. The offeror must establish Beta sites (at least one Government) to validate the WS-ICM and conduct at least four incremental progress demonstrations at 6, 12, 18, and 24 months after contract award accompanied by user required documentation. The WS-ICM containing the latest PCM, CEM, and OSM models and representative data from industry sanitized to protect the proprietary information of Government (possibly the F-22 SPO) and contractor (possibly one prime and at least two subcontractors) will be demonstrated with scenarios, screens, and reports.

PHASE III DUAL USE APPLICATIONS: The WS-ICM has come from a strong customer pull (SPOs and Contractors) who need tools to help them make accurate affordability decisions in the new acquisition environment. The market is large scale manufacturing operation programs.

REFERENCE: A white paper is available from the topic author outlining the hierarchical nature and cost elements associated with a Weapons System Program such as the F-22. In addition, a briefing from the F-22 SPO to the Defense Manufacturing Conference in December, 96 is available on the internet at: (http://mantech.iitri.com/pubs/dmc96pro/spiker/index.htm)

AF98-232 TITLE: Aero Propulsion & Power Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop innovative approaches for advanced propulsion systems and electrical power concepts for manned/ unmanned applications.

DESCRIPTION: The Aero Propulsion & Power Directorate aggressively pursues major performance advances in all components of gas turbine engines under the Integrated High Performance Turbine Engine Technology (IHPTET) initiative. Technologies derived under this initiative have resulted in higher thrust to weight ratios and improved efficiencies. The focus of this topic is to consider those aspects in the design of gas turbine engines and other prime propulsion concepts, electrical power systems and energy storage devices that could support manned and unmanned mission requirements. The innovative approaches may include, but are not limited to, the use of microelectromechanical (MEMS) and mesoscopic machine technology. Emphasis would be on affordability, reliability, and lightweight designs without compromising range and payload. New analysis techniques, innovative designs, hybrid propulsion systems and electrical power concepts to support manned and unmanned air vehicle (UAV) applications are solicited.

PHASE I: Define the proposed concept and predict the performance of the proposed design. Explore the feasibility of a new concept or concepts, through analysis and/or small scale testing to demonstrate the merits of a flexible modular design that can meet various mission applications.

PHASE II: Provide detailed analytical derivations and prototypical device or hardware demonstrations.

PHASE III DUAL USE APPLICATIONS: UAVs can present an effective alternative for some civil sector missions, for example meteorological data gathering, atmospheric sampling and surveillance. Forest Service mapping and fire spotting, agriculture and ranching support, coastal and border patrol and surveillance, and storm tracking and disaster assessment are some specific areas that may be exploited with UAVs.

REFERENCES:
1. "Unmanned Vehicle Systems: Military and Civil Robots for the 21st Century & Beyond", Dr. Robert Finkelstein & Steven Shaker, Pasha Publications, 1616 North Fort Meyer Dr., Suite 1000, Arlington, VA 22209, 1994.
2. "Introduction to UAV Systems", Paul Fahlstrom and Thomas Gleason, UAV Systems Inc., 5537 Twin Knolls Rd., Suite 439, Columbia, MD 21045, 1995.
3. "FY97 Aero Propulsion & Power Technology Area", Headquarters Air Force Material Command, Directorate of Science & Technology, Wright-Patterson AFB OH, WL-TR-97-2000, ADA 318 710, World Wide Web address: http://stbbs.wpafb.af.mil/STBBS/info/taps/fy96/propulsn/final.doc

AF98-233 TITLE: Power Technologies for Ground Support

CATEGORY: Advanced Development; Aerospace Propulsion and Power

OBJECTIVE: Develop efficient, high performance electric power systems, or components for ground support applications.

DESCRIPTION: This topic seeks innovative proposals to develop power systems for ground support of Unmanned Aerial Vehicle (UAV) systems, air combat training, Air Expeditionary Forces (AEF) and remote sensor sites. The proposed power systems should be based on thermal-to-electric conversion technologies.

Small, highly efficient power systems benefit USAF operations in a number of ways: higher efficiencies reduce the frequency of fuel resupply in the field, improve mobility, reduce logistics expenses, and address environmental issues associated with operation of inefficient fossil fuel power systems and radioisotope power systems in environmentally sensitive regions. Proposals submitted should offer innovative concepts that transition advanced conversion technologies to use in mobile, and/or unattended power systems. Three energy conversion technologies that are capable of producing high power system efficiencies are free piston Stirling engines (FPSE), alkali metal thermoelectric converters (AMTEC) and thermophotovoltaics (TPV). Proposals may address an innovative solution to a subsystem (combustor, power conditioning, conversion system, etc.) problem or the proposal

may address an innovative solution to a complete power system. Engine driven generators at 35kW are used for AEF and UAV ground station applications. Proposed power systems for this type of application must exhibit superior performance to the 35kW class of engine driven generator. For air combat training ranges and remote sensor site applications, desired features include: an overall system efficiency of at least 10%; i.e., 4-5 times present state-of-the-art thermoelectric generator systems; output power levels of 50 to 200 watts electric. All applications are subject to an operating temperature environment +100 F to -135 F, and multifuel combustor using JP-4, kerosene, propane, natural gas, etc.

PHASE I: Determine feasibility of the proposed system or component. Experiments that verify analytical results would be of special value. Cost and performance estimates that compare the proposed power system to its competitor system should also be included. Sufficient progress must be accomplished to make a low risk go/no-go decision for a phase II contract. Any Phase II proposal resulting from a Phase I award should clearly define commercialization strategy in accordance with Solicitation 98.1.

PHASE II: Provide an operable prototype component or system that is completely suitable for the intended application. A complete, stand-alone system is desirable; however, proposals that address innovative improvements to existing technologies such as combustors, and energy conversion devices are also welcome. The prime consideration must be deliverable hardware in phase II and a clear demonstration of a manufacturable device, component or system that improves the existing technology either through exceptionally high performance, significantly reduced cost, or improved robustness.

PHASE III DUAL USE APPLICATIONS: For small-scale (to approximately 500 watts) electric power systems, present commercial and government systems are based thermoelectric (TE) conversion technology that is 3-5% efficient. Improving overall performance by implementing advanced conversion technologies dramatically reduces overall cost of operations. Some commercial uses of these power systems include air and marine navigation stations, gas metering stations, weather monitoring stations, off-shore platforms, communication relay stations, cathodic protection, and oil exploration. In addition to commercial applications, DoD uses for these types of power systems also include air training range communications, training range data relay stations, seismic observatories, remote monitoring stations, and intelligence gathering stations.

REFERENCE: T.R. Lamp, Power System Assessment for the Burnt Mountain Seismic Observatory, Report No. WL-TR-94-2026, Wright Laboratory, WPAFB, OH, Mar 94. ADA 283 905

AF98-234 TITLE: Power Technologies for Unmanned Aerial Vehicles

CATEGORY: Advanced Development; Aerospace Propulsion and Power

OBJECTIVE: Develop efficient, high performance electric power systems, or components for UAV flight platforms.

DESCRIPTION: This topic seeks proposals with innovative concepts related to energy storage or photovoltaics for solar-powered unmanned aerial vehicles (UAVs). Energy storage includes batteries, fuel cells and flywheels.

There has been increased emphasis within DoD regarding commitment to the use of UAVs. The convergence of technological advances in computers, avionics, solar cells, sensor packages, energy storage, and lightweight materials offer the prospect of truly effective Solar-UAV systems. Power and mass of photovoltaic (PV) systems play an important role in enabling electrically-powered UAVs for a variety of military and civilian missions. PV-powered UAVs offer a number of unique military operational advantages; they exhibit virtually nonexistent thermal signatures, their use of light-weight (non-metallic) materials make them virtually radar transparent, their reliance on a non-combustible propulsion system enables operation at extremely high altitudes (60,000-100,000 ft), and their use of unlimited solar power together with energy storage enables very long duration missions. PV arrays for solar-powered UAVs will have to be robust, affordable, efficient and ultra-lightweight. Proposals are sought that contain concepts for PV cells that approach or exceed performance parameters of 18% conversion efficiency, and 1100 watts/kg. Innovative concepts for improving robustness, cost and manufacturability of PV cells are also desired. For effective PV-powered UAV operations, a rechargeable energy storage capability better than 250 watt-hours/Kg is needed.

PHASE I: Determine feasibility of the proposed system or component. Experiments that verify analytical results would be of special value. Sufficient progress must be accomplished to make a low risk go/no-go decision for a phase II contract. Any Phase II proposal resulting from a Phase I award should clearly define commercialization strategy in accordance with Solicitation 98.1.

PHASE II: Provide an operable prototype component or system that is completely suitable for the intended application. With respect to photovoltaics, proposals are desired that show a clear potential for delivering large-scale PV-arrays (including interconnects, fault protection and encapsulation) by the end of a phase II effort. The prime consideration must be deliverable hardware (PV or energy storage) in phase II and a clear demonstration of a manufacturable device, component or system that improves the existing technology either through exceptionally high performance, significantly reduced cost, or improved robustness.

PHASE III DUAL USE APPLICATIONS: High performance photovoltaics and energy storage devices have a number of suitable DoD and commercial applications. Commercial ventures involving solar power vehicles include low cost communications systems for third world nations, atmospheric research and weather tracking.

REFERENCES:
1. K.C. Reinhardt, T.R. Lamp, and A.J. Colozza, Solar-Powered Unmanned Aerial Vehicles, 31st International Energy Conversion Engineering Conference, Washington, DC, Aug 11-16, 1996.
2. S.F. Brown, The Eternal Airplane, Popular Science Magazine, p70, Apr 94.

AF98-235 TITLE: High Mach, Air-Breathing, Storable-Fuel Engine Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop key technologies for advanced cycle engines operating from Mach 0 to 8.

DESCRIPTION: Engines of interest in the Mach 0 to 8 flight regime include Pulse Detonation Engines (PDE) and other Advanced Ram Compression concepts that use noncryogenic fuel. The turbo combined cycles and turbomachinery aspects of cycles such as turboramjets (TurboRJ) and air-turborockets (ATR) are not of interest under this topic. The PDE cycle combines the simplicity and efficiency of detonation wave combustion with the capability of air breathing propulsion at flight Mach 0 to 5. Ramjet/scramjet engines offer longer range compared to rocket propulsion, and lower cost and higher speeds when compared to turbine engines. Mach 3 to 6 ramjet and Mach 6 to 8 scramjet technologies pertinent to simplicity, low weight, low cost, and high specific impulse are of great interest. These technologies include total engine concepts; air intake systems; exhaust nozzles; solutions to reduce internal drag and total pressure losses; innovative piloting, fuel ignition, and flameholding methods; solutions to reduce the length, weight, and cost of the inlet, combustor, nozzle, and other components; ramburner/scramburner structures, materials, and cooling techniques; endothermic fuel reactors and other fuel issues; and nonequilibrium plasmas/weak ionization and effects on drag and combustion. Proof-of-concept testing is preferred, but analytical investigations will be considered at the Phase I level.

PHASE I: Identify novel concepts and quantify their payoff when integrated into the selected high Mach propulsion system, and conduct small-scale experiments to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis must be performed to demonstrate a high degree of concept feasibility, and a plan for experimental direction in Phase II must be shown.

PHASE II: Large scale development and testing which would include identification of appropriate facilities and pertinent capabilities.

PHASE III DUAL USE APPLICATIONS: High Mach, advanced airbreathing, storable-fueled engines have potential application to a multitude of vehicles which require efficient acceleration and cruise capabilities. Military application might include long-range high-speed aircraft for reconnaissance and strike missions, stand-off missiles, UAVs, and drones. Commercial applications might include high-speed civil transport or passenger aircraft. Dual-use applications include military/commercial space launch vehicles which require an airbreathing propulsion system for the initial atmospheric boost phase. The Pegasus launch vehicle and similar systems could benefit from the use of airbreathing boost propulsion.

REFERENCES:
1. Hay, .W., Peschke, W.T., and Guile, R.N., Hydrocarbon-Fueled Scramjet Combustor Investigation, AIAA-90-2337.
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3. Aarnio, M. J., Hinkey, J.B., and Bussing, T. R. A., Multiple Cycle Detonation Experiments During the Development of a Pulse Detonation Engine, AIAA 96-3263.
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AF98-236 TITLE: Reduced Chemical Kinetic Models for Practical Fuels

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop techniques to incorporate detailed chemical reaction mechanisms for hydrocarbon fuels into complex multi-dimensional fluid dynamics problems.

DESCRIPTION: Aviation fuels such as Jet-A, JP-4, JP-5, JP-7, JP-8 and endothermic fuels for hypersonic aircraft consist of blends of higher order hydrocarbons, including alkane and aromatic molecules. Studies of the detailed combustion chemistry of these fuels have generally been confined to simplified or even simplistic descriptions using spatially homogeneous or one-dimensional reacting flows. However, with advances in computational capabilities, the practice of considering detailed chemical kinetics in multi-dimensional combustion models is becoming more wide-spread. Still, the introduction of detailed chemical reaction mechanisms into complex multi-dimensional fluid dynamics problems for aviation fuels is not practical at the present time. Fortunately, many aspects of combustion in practical devices are controlled by fluid mechanic processes rather than by chemical kinetics. However, pollutant formation, ignition delay, engine efficiency and operation at short residence times over a broad range of conditions, particularly in high-speed aircraft propulsion systems, are all kinetically controlled processes. Thus, simplified reaction mechanisms which have been thoroughly validated must be developed in order to address specific issues arising in realistic combustor configurations. The US Air Force has constructed a kinetic model that includes alkane, alkene, benzene, simple substituted aromatic (e.g., toluene, ethylbenzene, styrene and phenylacetylene) and simple polycyclic aromatic (e.g., naphthalene and indene) molecules (Maurice, 1996). The kinetic model has been comprehensively validated through comparisons with experimental data in intermediate to high temperature combustion environments. Under the present program, innovative techniques are sought to simplify the above mentioned detailed kinetic mechanism while retaining the ability to predict critical reaction time scales and free radical profiles. Emphasis will be on developing and automating the reduction methodology.

PHASE I: Identify a suitable kinetic mechanism reduction technique and demonstrate its feasibility in a spatially homogeneous reactor configuration.

PHASE II: Incorporate the reduced mechanisms into multi-dimensional combustion models.

PHASE III DUAL USE APPLICATIONS: Reduced chemical kinetic models for aviation fuels can be used to conduct computational fluid dynamics (CFD) analysis and cycle analysis of the fuel/air combustion process in turbojet and ramjet applications. These analyses can then be used to improve the engine combustor design for both military and commercial aircraft. Potential customers for a commercial version of reduced kinetic fuel models include aircraft engine manufacturers, DoD and NASA, and CFD code developers. The small business would be also be able to adapt the technology to the home and industrial energy and automotive industries.

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AF98-237 TITLE: Advanced Multidimensinal Imaging Technologies for Combustion Diagnostics Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop and demonstrate advanced detection, signal-processing, and storage technologies for imaging key combustion parameters.

DESCRIPTION: The development of high-performance/low-emissions combustors is an enabling technology for the continued advancement of aircraft propulsion and power systems. Many of the goals associated with the Integrated High-Performance Turbine Engine Technology (IHPTET) Program demand revolutionary improvements in combustor characteristics. Nonintrusive, laser-based diagnostic techniques play a critical role in addressing these challenges. Combustion diagnostics provide feedback regarding key performance parameters including combustion temperatures, species concentrations, and other important flow field parameters. The available data is essential for evaluating advanced combustor concepts. In addition, diagnostic techniques are ideal for validating computational fluid dynamics and chemistry (CFDC) codes associated with emerging combustor design methodologies.

Multidimensional imaging of key combustion parameters represents one of the most exciting and potentially revolutionary recent developments in the diagnostics arena. Spatially and temporally resolved images of temperature, pressure,

velocity, and species concentrations present tremendous opportunities for improved understanding of fundamental combustion processes. This increased understanding is essential to exploring turbulence and improving the performance of advanced combustors.

A number of important technologies must be developed to realize the potential of multidimensional imaging. Several of these technologies have been addressed through past SBIR topics targeting novel radiation sources for advanced diagnostics (AF97-183), measurements under actual engine conditions (AF96-170), and ultrafast-laser-based techniques for absolute number density determinations (AF95-188). To complement the sources realized through these and other programs, this topic seeks the development and demonstration of advanced detection technology to provide spatially and temporally resolved time-evolving images of key combustion parameters. For example, modulation/demodulation-based laser diagnostic techniques show great promise for delivering quantitative determination of key combustion species; however, the complications of combusting environments, particularly spurious optical signals and noise, impact the potential of this approach. Topic objectives include specialized developments in image acquisition/detection technology, post-detection signal processing, and data storage and retrieval designed to address these complications. Ideally, proposed approaches should provide quantitative, real-time imaging of key combustion parameters in multiple spatial dimensions.

PHASE I: Experimentally demonstrate the potential for proposed detection, signal-processing, and/or storage technologies to provide improved measurement of key combustion parameters compared to existing state-of-the-art approaches. In particular, enhanced spatial and temporal resollution, improved sensitivity, reduced camera noise, increased data transfer rates, extended data storage capability, demodulation compatibility, and bakground rejection all repesent significant performance enhancements that might be pursued during Phase I. Modeling and other computational support of proposed concepts are advantageous but not sufficient for a Phase I effort. Simply proposing a novel detector and/or signal-processing/data-storage device is also insufficient; the potential advantages the proposed device brings to combustion diagnostics applications must be thoroughly explored.

PHASE II: Provide complete demonstration and documentation of the performance gains associated with the detection, signal-processing, and/or storage technology. Ideally, this demonstration should be achieved in conjunction with a combustion application of interest to the Air Force.

PHASE III DUAL USE APPLICATIONS: The combustor design methodologies validated by using imaging technologies associated with this topic will have tremendous impact on both military and commercial aviation, particularly as these techniques contribute to the development of high-performance/low-emissions combustors. The imaging technologies themselves have tremendous dual-use commercialization potential as well. The recently released National Critical Technologies Report identified the development of imaging sensors among a group of 27 critical technologies that must be vigorously pursued. Specifically, the authors of the report advocate the identification, development, and implementation of imaging technologies for energy, functional-diagnostics, environmental-quality, and national-security applications. Fields of endeavor that stand to benefit from such imaging technology include advanced materials processing (e.g., chemical vapor deposition), biotechnology (e.g., noninvasive ballistic imaging for mammography or early detection of disease), communications (e.g., high-bandwidth optical signal processing), low-light-level detection in national-security applications, and energy and environmental applications (e.g., performance optimization and emission reduction in advanced gas turbine combustors).

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AF98-238 TITLE: Combustor/Heat Exchanger Innovative Technology Research

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Identify innovative in-line heat exchanger designs for high performance aircraft gas turbine engine combustors.

DESCRIPTION: Thermals loads that will be imposed on Integrated High Performance Turbine Engine Technology (IHPTET) Phase III and advanced concepts engines will become increasingly severe as critical demands are placed on the structural materials and thermal capabilities of the engine. As IHPTET calls for higher combustor inlet and exit temperatures, the total burden for engine cooling will be shifted to the fuel. Future gas turbine engine combustors will burn liquid and gaseous fuel. Current AF efforts require the use of heat exchangers to cool the cooling air with fuel. Current heat exchangers designs lack the capability of detecting and measuring fuel leaks, they are heavy and do not have the temperature capability required.

PHASE I: Will require an analysis to identify innovative in line heat exchanger design concepts. Specific knowledge of current Air Force work in this technical area is required.

PHASE II: Work will be focused towards demonstrating design concepts. These design concepts shall be consistent with the practical features and environmental limitations of gas turbine engines. The information gained under phase I will be used to design and fabricate a subscale test article which exhibits the anticipated conditions in a modern gas turbine engine. A test plan shall be prepared identifying the testing and development work required to validate the concept identified. Testing shall demonstrate both the capability of the test article and the effectiveness of the proposed heat exchanger system.

PHASE III DUAL USE APPLICATIONS: All commercial gas turbine engines require combustion systems. Demonstration of advanced heat exchangers concepts will provide great benefits in extending hot section life and performance, therefore, directly benefiting commercial gas turbine engines.

REFERENCE: Heat Exchanger Design Handbook, 5 Vols., Begell House Publishers, Inc., 1983.

AF98-239 TITLE: Power Generation and Thermal Management

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop techniques, devices and components for aerospace power generation and thermal management/control.

DESCRIPTION: Electrical machines are needed that operate at high speeds (30-70 krpm) while generating power up to 300 kW for APU and main engine applications. A machine running at higher speed can usually attain a higher power density and lower weight. However, a high power density motor or generator poses difficult technical challenges generally associated with the generation of high heat loads from magnetic and electrical losses and windage. Proposals are solicited which offer ways to either reduce these heat loads, or to ameliorate their effects. Examples of areas of interest include, but are not limited to high temperature windings and potting materials (>400 degrees C, 600 degrees C goal) for switched reluctance machines (SRMs), fault tolerant winding configurations for permanent magnet (PM) generators, non-lubricated active or passive rotor suspension systems (including hybrids) for APUs, and on-line diagnostic approaches for monitoring/controlling APU rotor/bearing system stability.

Innovative thermal management concepts are also sought in the areas of conventional and high temperature electronics and actuator cooling. An emerging family of silicon carbide (SiC), silicon nitride (SiN), and gallium arsenide (GaAs) power electronics will operate at junction temperatures >200 degrees C in the near term and >600 degrees C far term. Even though the efficiencies of these devices will be much greater than conventional silicon devices, the power densities will be 4 to 8 times higher. Therefore, even greater power dissipation levels and waste heat fluxes will have to be managed. Passive thermal management concepts for high performance aircraft have the potential of being reliable and simplistic in design, and are therefore preferred. However, such concepts must manage the inherent coupling of transient heat generation and transient acceleration induced forces, and their effects on the cooling performance of the device. For example, as a direct result of aircraft orientation, altitude, and speed, efficient cooling of flight actuation components results in addressing a transient heat generation problem which is coupled to transient accelerations and transient external heat sink conditions. When active cooling is proposed, existing aircraft fluids such as JP 8,polyalphaolefin, 7808, or 5606 must be used, unless that cooling system is conceived as a line replaceable unit (LRU) or is modular. Reduction of initial cost, maintenance, and logistics should be a key objective for all efforts. The effects of altitude or the impact of the use of compressor bleed air must be addressed when air cooling is proposed. Areas of interest include but are not limited to, microchannel cooling, immersion cooling, heat exchangers with enhanced heat transfer surfaces, and the use of micro electro mechanical systems (MEMS) to control and enhance interfacial heat transfer.

PHASE I: Develop a detailed technical definition of the problem, identify a proposed solution, and demonstrate the key technologies enabling the use of that solution.

PHASE II: Concentrate on development of prototype components, subsystem demonstrations, and hardware development.

PHASE III DUAL USE APPLICATIONS: These technologies have application for all high speed motors, generators, actuators, and power electronics which may be used in future high power density electric/hybrid transportation vehicles (commercial air, high speed rail, and electric car), power generation, and manufacturing facilities.

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2. "High Temperature Generator Development," AFAPL TR 74 69, Robert Fear, etal., Westinghouse Electric Corporation, AD 786

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AF98-240 TITLE: Advanced Instrumentation and Simulation Technology for Ramjet/Scramjet Combustors

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OOBJECTIVE: Develop instrumentation and computational fluid dynamic methods for measurement/simulation of subsonic and supersonic combusting flows.

DESCRIPTION: Obtaining accurate measurements of various flow parameters in a combusting flowfield without disturbing the flow is a difficult task. Various optical "Flow" diagnostics techniques are currently under development with the eventual goal of being used in the harsh environments of direct connect and free jet facilities. The need still exists for the development of new techniques to allow accurate point or field measurements of velocity, temperature, density, fuel concentration, and the constituency of the exhaust effluence in hydrocarbon and hydrogen fueled ramjet and scramjet propulsion systems. These techniques are also vital to the development of CFD simulation software. The development of such software requires that accurate and precise measurements be performed concurrently with and in a complimentary fashion to algorithm development and physical model validation. Shortcomings exist in the simulation of chemical kinetics, turbulence, turbulence-chemistry interaction, multi-hase flow, unsteady effects and acoustic phenomena. New robust miniature instrumentation is required to assess the performance of potential subsonic and supersonic ramjet combustors and various flow path components in free jet and direct connect facilities. In particular, the development of micro-scale high frequency sensors for measurements of wall pressure, temperature, skin friction and heat fllux capable of surviving high enthalpy (up to Mach 8) flight conditions is desirable. Single- and multi-element addressable micro-opto-mechanical sensors are required for engine health monitoring and flow control. These sensors shall require minimal pre- and post-test calibration. The development of measurement techniques must coincide with the development of simulation techniques to ensure that the physical quantities needed by software developers are measured to the required level of accuracy. Simulation technology development should focus on chemical kinetics, multi-phase flow, and temporal and/or spatial resolution of the small-scale fluctuations found in 3d chemically reacting flows typical of ramjets and scramjets.

PHASE I: Develop and refine measurement techniques and instrumentation concepts in conjunction with CFD software to allow proof of concept and demonstration of relevance in representative subsonic and supersonic flows with and without heat release.

PHASE II: Develop the instrumentation and associated measurement techniques and validate the CFD software to the point where they can be used n realistic combustor temperature and pressure environments of direct connect and free jet facilities.

PHASE III DUAL USE APPLICATIONS: Potential for dual use is great. Similar if not identical instrumentation and measurement techniques are required in automotive, ground power generation, incineration, and the aerospace industries. Commercial success is, however, dependent on sensor/instrumentation durability, practicality, accuracy, and cost. There is a great market in the US and abroad for commercialization of micro sensors and optical instruments. Similarly CFD/simulation techniques developed under this topic could be marketed to the automotive, ground power generation, incineration, and the aerospace industries.

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AF98-241 TITLE: Auxiliary Bearings for Magnetically Supported Rotors

CATEGORY: Advanced Development; Air Vehicles/Space Vehicles

OBJECTIVE: Develop auxiliary bearings for magnetic bearing systems.

DESCRIPTION: Studies of active magnetic bearing systems have shown the potential payoffs and high risks involved in the development and application of this technology for advanced aircraft gas turbine engines. Active magnetic bearings represent an innovative approach to aircraft engine rotor support with the potential of providing significant benefits not possible with conventional rolling element bearings. The successful application of magnetic bearings would result in engines with no oiling systems, high rotor speeds, reduced blade tip and seal clearances, reduced weight, and enhanced rotor dynamic control. However, technology for advanced, fail-safe auxiliary bearings has been identified as a critical factor in successfully achieving an operational aircraft engine magnetic bearing system. In an aircraft engine configuration wherein the primary support for the mainshaft rotor is provided by an active magnetic bearing system, the auxiliary bearings would serve as a fail-safe support mechanism. The unlevitated rotor will be statically supported by the auxiliary bearings. Additionally, in the event of a power failure in the magnetic bearing control circuit or during excessive bearing loading conditions caused by the loss of turbine or compressor blades or due to a severe aircraft maneuver, the selected auxiliary bearings must be capable of withstanding these high loads so as to prevent contact between the magnetic bearing rotor and stator. The auxiliary bearings, under these conditions, must have sufficient life to enable the pilot to fly his aircraft safely to the nearest airbase.

PHASE I: The goals will include the design and analysis of innovative auxiliary bearing concepts with potential of meeting the speed, temperature, and loading requirements, as related to the conditions described above.

PHASE II: The activities would include the detailed design, fabrication, and testing of selected promising auxiliary bearing configurations.

PHASE III DUAL USE APPLICATIONS: Auxiliary bearings offer the ability to safely support magnetically levitated high speed rotors in the event of magnetic bearing failure or overload. Thus, the technology has benefits for a variety of high speed rotating machinery equipped with magnetic bearings. Examples include natural gas pipeline compressors, turbopumps, and power generation gas turbine engines.

REFERENCE: Feasibility of Magnetic Bearings for Advanced Gas Turbine Engines, D. H. Hibner and L. Rosado, presented at the 1991 International Symposium on Magnetic Suspension Technology, August 1991, NASA Conference Publication 3152, 92N27738.

AF98-242 TITLE: Aircraft Turbine Component Technology-Aerodyanmics and Cooling

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop concepts for improving aerodynamic performance and reducing cooling flow requirements of turbine components.

DESCRIPTION: Proposals should address the development of aircraft engine turbine component technologies in the area of aerodynamics and heat transfer. A major trend in turbine components for aircraft engines is increased loading, increased turbine inlet temperature and reduced cooling air. New design concepts, analysis techniques, experimental test methods and high temperature instrumentation development are needed to further the technology in these area. Proposals should focus on effort that contributes to meeting the goals of the Integrated High Performance Turbine Engine Technology (IHPTET) program.

PHASE I: Explore the feasibility of a new concepts, through analysis or small scale testing, to demonstrate the potential merits of the concept.

PHASE II: Provide detailed analytical derivations, prototype and/or hardware.

PHASE III DUAL USE APPLICATIONS: Higher performance turbine engines and associated technologies will lead to more efficient, quieter and environmentally acceptable propulsion systems. Turbine technology imporvements play a major role in military applications and there is great potential to transition to commercial use.

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1. "Upgrading Jet Turbine Technology." Michael Valenti, Mechanical Engineering, Dec. 1995, pp 56-60.
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AF98-243 TITLE: High Heat Sink Jet Fuels, Additives and Test Methods

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop advanced high heat sink thermally stable jet fuels, additives, improved test methods and high temperature fuel system components.

DESCRIPTION: Jet fuel is a primary coolant used to cool aircraft and engine subsystems on current and future aircraft Current jet fuels (JP-8, JP-5) break down at high temperatures to form gums, varnishes and coke that can plug fuel nozzles, afterburner sprayrings and spraybars, fuel manifolds and fuel controls. Advanced propulsion concepts can require up to 1500 Btu/lb cooling from the fuel. To provide the necessary cooling the fuel must be resistant to degradation under both autoxidative and pyrolytic conditions and may be under supercritical or controlled cracking conditions (endothennic type fuels). In order to develop advanced high heat sink fuels, new fuel additives that suppress autoxidation and pyrolysis at temperatures as high as 450 Degrees C need to be developed. New test methods are needed to simulate the behavior of fuels at supercritical or cracking temperatures that can be used to determine fuel reaction chemistry, kinetics, heat transfer as well as chemical and physical properties at supercritical conditions. Advanced computational fluid dynamic models coupled with fuel degradation chemistry and advanced high temperature fuel system component simulators are required to determine the impact of fuel degradation in advanced aircraft and engine fuel systems. Jet aircraft produce chemical emissions that can be released into the atmosphere at high altitudes. Fuel additives that can be added to jet fuels in small quantities and suppress emissions need to be developed. Advanced emissions measuring techniques that can be used with research combustors to evaluate the effectiveness of these new fuel additives are also required.

PHASE I: Demonstrate the feasibility of the technology and to quantify the payoffs for both military and commercial applications.

PHASE II: Demonstrate the application of the technology, demonstrate a prototype of the technology, validate performance, and quantify payoffs for both military and commercial applications.

PHASE III DUAL USE APPLICATIONS: All technologies developed under this topic have both military and commercial jet fuel applications due to the similarities of the jet fuels (i.e. JP-8 is commercial Jet A-1 fuel with a military additive package).

REFERENCES:
1. "Deposition of High Temperature Jet Fuels," T. Edwards and J. V. Atria, ACS Petroleum Chemistry Division Preprints Vol 40, No. 4, pp. 649-654, August 1995.
2. "High Temperature Cracking and Deposition of an n-alkane Mixture," T. Edwards and J. V. Atria, ACS Petroleum Chemistry Division Preprints, Vol 41, No. 2, pp. 498-501, Mar 1996.

AF98-244 TITLE: Advance (High Temperature of Cryogenic) Dielectrics and Capacitors

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop innovative dielectric materials and/or capacitor devices for two different thermal operating environments:
1) -55 degrees C to > 300 degrees C
2) 20K to 120K

DESCRIPTION: Power electronics systems will be a pervasive technology in the next generation weapon systems. Typical power systems include motor drives, inverter/converter for switched reluctance starter/generator systems, DC to AC inverters, DC to DC converters, and pulse forming networks. Common to all of these systems are capacitors, which are numerous and are critical in the operation of the system. Today's capacitors are the weakest link in power electronic system reliability and are limited in temperature capability to a maximum of 125 degrees C. Current application temperatures range from -55 to 200 degrees C and some applications may require > 300 degree C operation with superior electrical performance. Attention to lowering the leakage currents, lowering the dissipation factor, increasing the voltage breakdown strength and increasing the dielectric constant over the current performance is desired. For electrochemical capacitors, energy density should approach 20 Wh/L while the energy density for energy storage and pulse power capacitor devices should approach 10 J/g. For DC/AC filter applications, the equivalent series resistance is important and should be kept below 3 milliohms and the drift properties should be held at below 10% over frequency, voltage and temperature ranges. For integrated passives, attention to lowering the dissipation factor and leakage currents is paramount. Candidate proposals shall address novel and innovative high temperature dielectrics and/or high density packaging and/or manufacturing technologies to reduce cost. A large range of specific uses include DC and AC power filtering, energy storage, high repetition rate (pulse power)

devices, high energy back-up or hold-up power devices, and small signal (SMT, MCM, etc.) capacitor applications for controls. 2) Cryogenic capacitor devices operating in the More Electric Aircraft (MEA), specifically in the temperature range of 20K to 120K, are of interest. These cryogenic systems include capacitor devices in motors, generators, power conditioning and distribution, circuits and energy storage networks, etc. The same superior electrical properties are desired for the cryogenic area as listed for the high temperature environment.

PHASE I: Demonstrate innovative capacitor approaches with substantial improvement in capacity, dielectric constant, voltage breakdown strength, dissipation factor, and temperature capabilities. Prototype laboratory capacitors should be fabricated and tested to demonstrate the feasibility of the technology.

PHASE II: Demonstrate development of prototype capacitor components using innovative dielectric material or advanced high density packaging or manufacturing technology or a combination thereof. Actual application testing should be performed and electrical, thermal and life assessments made.

PHASE III DUAL USE APPLICATIONS: Capacitors are used in nearly every commercial and military system that consumes electrical power. Potential applications include all consumer electronics, medical electronics including defibrillators, automotive electronics including electric vehicles and electric utilities. High temperature applications include aircraft engine ignition systems and electrical actuation, deep oil well instrumentaiton, and under the hood automotive applications.

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AF98-245 TITLE: Real-Time Turbine Engine Fault Detection/Condition Monitoring System (FADCoMS)

CATEGORY: Advanced Development; Aerospace Propulsion and Power

OBJECTIVE: Develop a real-time FaDCoMS and demonstrate it during engine test.

DESCRIPTION: The development of computing processing power in recent years has enabled us to consider the computation of synchronous and non-synchronous frequencies that can be inferred from a rotating mass. The development of eddy current, acoustic and light probes can derive the frequencies that exhibit high cycle fatigue damage as well as detect a flaw like the "wheel taper's hammer." The computation of such frequencies will enable us to deduce considerable knowledge about a component's health and performance and ultimately it will enable us to detect flaws before they cause damage or fail catastrophically.

PHASE I: Develop a FaDCoMS that can distinguish between the synchronous and non synchronous vibration that are exhibited within a shaft, disk and blade as an assembly and as individual components and detect the initiation and growth of a deformation or crack .The FaDCoMS will be able to detect and position 0.001" cracks as a minimum requirement within a shaft, disc or mounted blade assembly as well as trace the propagation.

PHASE II: Develop the FaDCoMS to achieve the capability to: detect resonance response, detect flutter, detect foreign object damage, assess life, detect onset of stall, deduce engine efficiency and deduce rotor whirl due to stall, imbalance or bearing distress. Additional to these prerequisites the FaDCoMS should show the ability to detect deformation or cracks within the rotating assembly on an installed engine over its complete power range.

PHASE III DUAL USE APPLICATIONS: The development of a true real-time FaDCoMS will be a major safety benefit by preventing blade or disc failure as well as achieving maintenance cost reductions within the civilian aerospace community.

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AF98-246 TITLE: Probabilistic Diagnostic and Prognostic System (ProDaPS)For Gas Turbine Engines

CATEGORY: Advanced Development; Aerospace Propulsion and Power

OBJECTIVE: Develop a ProDaPS capability for turbine engine health during flight.

DESCRIPTION: The development of propulsion technology for greater power to weight goals and the need to show improved reliability requires major advances in control and condition technology. The acquisition of real-time engine data is already achievable, however the interpretation and utilization of such data is difficult. With the advances in computer technology and probabilistics as a statistical science, we can now realize a true real-time diagnostic and prognostic capability of performance, life and health of an engine. This SBIR activity will assist in the development work that is required to provide a future predictive methodology that is able to deduce accurate event predictions and solutions to reduce engine life cycle costs and enhance operational capabilities.

PHASE I: Develop a ProDaPS that can provide real-time diagnostic and prognostic assessment of creep and fatigue life, component condition and life consumption, engine performance and engine health based on actual or simulated engine sensed data with a high level of accuracy. The system will accept performance and historical information to produce its own expert system; it will then show the capability to monitor, predict and inform the required monitors, while developing its own knowledge base.

PHASE II: Develop the ProDaPS to fly on an aircraft/engine and demonstrate real-time diagnostic and prognostic capabilities of an engine's performance, life and health. The system will show the ability to validate probabilistic design and life codes and confirm that the assumed PM sensitivities are valid. The system must present technical data related to the engine's status in a user friendly form. The system will demonstrate a redundancy capability, in that it will compensate for any sensor or system fault.

PHASE III DUAL USE APPLICATIONS: The development of a true real-time gas turbine engine ProDaPS will provide major maintenance and life cycle cost reductions to the civilian aerospace community.

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AF98-247 TITLE: Aircraft Power Electronic Components

CATEGORY: Advanced Development; Aerospace Propulsion and Power

OBJECTIVE: Develop efficient, high performance electric power components, or systems for aircraft applications.

DESCRIPTION: This topic seeks innovative proposals that address electrical power switching, blocking, and control concepts based on wide bandgap semiconductor (WBG) device technologies. This area specifically addresses power electronic device/sensor development with the ultimate applications being to satisfy the aggressive electrical power requirements for the More Electric Aircraft (MEA) program. Innovative proposals should address novel power device designs, solutions to processing issues related to WBG device fabrication, ohmic and rectifying contact metallizations, surface passivation/insulating layer development, and materials development and growth.

MEA applications demand high-power electronics with high-temperature capabilities for use in power management and distribution (PMAD), actuator motor control, on-site smart sensors, and data bus electronics. These electronics are required to operate reliably at temperatures of 350 C or greater due to the planned elimination of aircraft hydraulic systems which, translates to a reduction or elimination of the primary electronics cooling medium. WBG semiconductor compounds (SiC, III-nitrides and diamond) have been projected to be excellent semiconductors for high power, high frequency and high temperature applications. For applications involving high powers (1000 volt @ 100 amp) and high temperatures (> 350 oC), it is critical, for example in MOS devices, to have thermally stable gate insulators with high breakdown voltages (>1000 volts), no remnant polarization, and a

dielectric constant with minimal frequency dispersion. Specific devices of interest include vertical and planar power metal oxide semiconductor field effect transistor (MOSFETs), Schottky and bipolar diodes, thyristors, and insulated gate bipolar transistor (IGBTs).

The primary objective of this topic is to seek solutions to critical issues related to WBG semiconductor power device development, including, but not limited to: 1) growth and characterization of native oxide dielectric insulators, 2) deposition and characterization of alternative dielectric insulators, 3) deposition and characterization of ohmic contacts on wide bandgap semiconductors, 4) ex situ and in situ techniques for cleaning WBG semiconductor surfaces, 5) ion implantation doping, 6) low specific resistivity ohmic contact metallizations with superior thermal stability, and 7) innovative concepts for smart power and optically triggered power switching elements. The goal of these efforts is to provide the technology base required to support low-cost device availability for applications involving power levels up to the 1000 volt, 1000 amp range, with an operational thermal stability exceeding 350 degrees C. WBG-based power semiconductor device development should include advanced power concepts such as "smart" power and "optically-triggered" power. The expanded use of microprocessor control gives the impetus for integrated logic circuits to decode commands and encode responses which constitutes the basics of "smart power". This solicitation also seeks proposals containing innovative concepts that integrate control technologies with the WBG-based devices.

PHASE I: Determine feasibility of the proposed system or component. Sufficient progress must be accomplished to make a low risk go/no-go decision for a Phase II award. Any Phase II proposal resulting from a Phase I award should clearly define commercialization strategy in accordance with Solicitation 98.1.

PHASE II: Develop an operatable prototypic component or system that is completely suitable for the intended application. A complete, stand-alone system is desirable; however, proposals that address only innovative improvements to existing component technologies such as highly efficient smart switching devices with improved power densities or improvements in the thermal stability of power electronic components are also welcome.

PHASE III DUAL USE APPLICATIONS: Dual-use commercialization potential is highly considered. The benefits of power device improvements primarily include significantly reduced power dissipation, operation capability for previously inaccessible harsh environments, or a relaxation of thermal management solutions for power electronics. Some commercial uses of these power systems include civilian aircraft, utility power distribution, hybrid/electric vehicle, and oil exploration.

REFERENCE: K.C. Reinhardt, J.D. Scofield, and W. Mitchel, "Directions in Air Force High-Temperature Power Electronics", Proceedings of Workshop on High-Temperature Power Electronics for Vehicles, Fort Monmouth, NJ, Apr 94.

AF98-248 TITLE: Advanced Sensors for Supercritical Engine Fuel Systems

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop new flow meter, density, vapor/liquid ratio sensors for high heat sink fuel system.

DESCRIPTION: Modern gas turbine engines have fuel systems which operate at fuel temperatures up to 325 Fahrenheit. Additional temperature capability is achieved using additives which delay the breakdown of the fuel. Use of additives has demonstrated maximum fuel temperatures up to 425 Fahrenheit. Advanced engines of the future may employ cooling systems which put significant additional heat in the fuel. These systems will operate at high temperatures (above 600 F). In these systems, jet fuel may be liquid, gas, or in a multiphase state. State-of-the-art sensors are capable of measurement of flow and density in liquid below 350 Fahrenheit. Measurement of gas parameters, typically air, is also accomplished for temperatures under 2000 F. These sensors can operate for many thousands of hours before replacement is required. Development of sensors capable of operating in the extended temperature environment of the high heat sink fuel system is required for control of an advanced engine. Investigation of new flowmeter concepts that will provide reasonable accuracy despite large variation in viscosity is appropriate. Investigation of methods to accurately measure density and mass flow are also critical. Consideration should be given to the high temperature of the fuel and its physical state. The potential for coking of the sensor must also be considered, as this may occur during temperature transitions between 350 F and 800 F.

PHASE 1: Investigate and develop conceptual designs for fuel system sensors which are capable of operating and surviving in the high heat sink fuel system environment. Designs should address measurement of one or more parameters of interest: flow, pressure, temperature, and vapor/liquid ratio.

PHASE II: Design and fabricate prototype hardware, based on the conceptual design work accomplished under the Phase I program. This hardware will be evaluated and used to demonstrate the feasibility of the technology for advanced turbine engines.

PHASE III DUAL USE APPLICATIONS: This technology has commercialization potential for both military and commercial turbine engines which can take advantage of the capabilities of higher temperature (425 F) jet fuels. Industrial processes that require accurate flow, density, and mass measurement in a high temperature environment will also benefit.

AF98-249 TITLE: Advanced Compression System Concepts

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop methods to advance aerodynamic and mechanical technology of compression systems and secondary gas path systems.

DESCRIPTION: Future compression systems will be demanded to pack more performance into smaller, lighter, more affordable configurations. Advanced designs are utilizing highly loaded, low aspect ratio, complex shape airfoils in multistage configurations. However, increased loading produces larger blade wakes, resulting in significant aerodynamic and aeromechanical interactions between stages. In addition, increased loading has produced stall margin and efficiency sensitivity to blade tip clearance levels. Aerodynamic and aeromechanical design capability does not fully account for the unsteady interactions, the effects of wakes due to complex airfoil shapes, or the sensitivity to tip clearances that exist in compression systems. Advanced measurement methods that improve the understanding of these phenomena are desired. In addition, innovative concepts that exploit an understanding of these phenomena are needed to meet the demands of future compression systems. Areas of prime technical importance include endwall, wake and secondary flows, time unsteadiness, forced response and mistuning.

Obtaining precise secondary gas path flow control will play an increasingly larger role in optimizing engine efficiency, as further gains in the major engine components become more difficult to achieve. Understanding primary and secondary gas path interactions can be critical to the performance of both. Reducing parasitic leakage and seal deterioration, while minimizing air needed for cooling, ventilation, and thrust balancing, is a significant challenge as the secondary gas path environment becomes more extreme. In addition, it is now anticipated that the cycle operating temperatures will dictate that cooled cooling air will be needed to maintain mechanical integrity in the turbine, and most likely in the compressor as well. Innovative concepts and models leading towards precise secondary gas path flow control are desired. Areas of particular interest include primary/secondary gas path interaction, film riding seals, trenching and shrouds, innovative thrust balancing, counter-rotation, and disk pumping.

Clear paths for incorporation into advanced military engine designs and design systems must be shown for each of the technology concepts proposed. Teaming arrangements with major engine contractors are highly encouraged.

PHASE I: Will result in feasibility demonstrations of concepts for the development of advanced compression system or secondary flow system design.

PHASE II: Will result in bench tested technology concepts for advanced compression system or secondary flow system design, adequately documented to be acceptable to the technical community.

PHASE III DUAL USE APPLICATIONS: The improvements gained in compression and secondary gas path system performance and efficiency are directly applicable to both military and commercial gas turbine engines.

REFERENCES:
1. Bullock, R., and Johnson, I., Aerodynamic Design of Axial-Flow Compressors, "Chapter III - Compressor Design System," NASA SP-36, 1965.
2. Puterbaugh, S.L., and Brendel, M. "Tip Clearance Flow-Shock Interaction in a Transonic Compressor Rotor," AIAA Journal of Propulsion and Power, Vol. 13, No. 1, Jan 1997, pp. 24-30.
3. "Unsteady Aerodynamic Phenomena in Turbomachines," AGARD-CP-468, Aug. 1989.
4. "Loss Mechanisms and Unsteady Flows in Turbomachines," AGARD-CP-571, Jan. 96.
5. Smith, L. H., "Wake Ingestion Propulsion Benefit," Journal of Propulsion and Power, Vol. 9. No. 1 Jan-Feb. 1993.

AF98-250 TITLE: Advanced Development of High Cycle Fatigue (HCF) Mgmt Tools

CATEGORY: Advanced Development; Aerospace Propulsion and Power

OBJECTIVE: Develop tools which enhance HCF prediction capability.

DESCRIPTION: HCF has been identified as a major maintenance problem in fielded engines and a major concern for future engines. The U.S Air Force is currently generating analytical tools and improved design concepts to reduce the occurrence of turbine engine

failures caused by HCF. In order to validate the models and proof the new design concepts, it is necessary to excite a bladed rotor, in an evacuated rotating environment, to the same excitation frequency and amplitude that the rotor experiences in the engine. Existing methods for excitation are either frequency limited, amplitude limited or the excitation system itself causes a samped response. In order to overcome these constraints, it is necessary to identify and develop novel approaches for evacuated spin pit excitation. The excitation method should be capable of accurately simulating the high cycle fatigue drivers experienced by turbine engine components.

PHASE I: Identify a concept for providing evacated spin pit excitation. Show the feasibility of implementing the concept with advanced high performance turbine engine technologies. This should include a scaled down demonstration of the concept.

PHASE II: Develop a full scale system to implement the concept derived in Phase I. The system should be capable of exciting 50 inch diameter components at constant speed through a full range of resonant conditions and aero loading amplitudes.

PHASE III DUAL USE APPLICATIONS: The development of highly HCF design systems will result in improved safety and achieve cost reductions to the civilian aerospace community.

REFERENCES:

1. Damage Tolerance Based Life Prediction in Gas Turbine Engine Blades Under Vibratory HCF, D. Walls, R. DeLaneuville, S. Cunningham, ASME, International Gas Turbine Engine and Aeroengine Congress & Exposition, June 1995.
2. An Efficient Method for Predicting the Vibratory Response of Linear Structures With Friction Interfaces, E. Bazan-Zurita, J. Bielak, J. Griffin, AFWAL-TR-86-2119, May 1988, ADA 197447.
3. Forced Response of Mistuned Bladed Disks, C. Pierre, NASA Lewis Research Center Workshop on Forced Response in Turbomachinery, Dec 1994, 95N19383.

AF98-251 TITLE: Square Canopy for ACES (Advanced Concept Ejection Seat) II Ejection Seat

CATEGORY: Engineering Development; Computing and Software

OBJECTIVE: Develop a square parachute canopy that will work on the ACES II ejection seat.

DESCRIPTION: The current ejection seat personnel canopies (or parachutes) are round in design and date back to 1940 technology. These have saved many lives but they fall so fast and hit the ground so hard, that they cause many injuries upon impact. Since 1940 square canopies were developed by "sport" parachutists. These can come down much slower and result in a glancing blow with the ground instead of a direct hit and almost totally eliminates injuries from impact. The problem is to make a square canopy that can be deployed at ejection seat speeds without failing, that will fit in the current allowed space for the round canopy. We want someone to develop such a canopy for the ACES (Advanced Concept Ejection Seat) II ejection seat. This is currently used on the F-16, A-10, B-2, and F-15 just to name a few of the military aircraft applications. It would be required to deploy exactly as the current system and fit within the current confines of the ACES II headbox.

PHASE I: Develop a canopy that will carry a 293 to 342 lb. landing load, fit in the current headbox, be able to withstand opening shocks at 300 knots, and not require any manipulation by the user. Computer simulation or engineering analysis that support the design and size are expected.

PHASE II: Prepare at least one full scale model and perform verification of the self operating requirement through witnessed tests that are high speed video recorded. If this is successful, then provide 10 canopies for testing to be performed by the government to verify performance and a complete level 3 data package for reprocurement of same.

PHASE III DUAL USE APPLICATIONS: The system developed can be used by non-military aviators of high speed aircraft (i.e. aerobatic sport aircraft, privately owned military surplus aircraft).

REFERENCE: McDonnell Douglas Drawings J114888 and A114922 (both available upon request)

AF98-252 TITLE: Artificial Intelligence Exchange and Service Tie to All Test Environments (AI-ESTATE) Implementation

CATEGORY: Engineering Development; Computing and Software

OBJECTIVE: Develop a diagnostic reasoner based on IEEE published and draft AI-ESTATE standards that is compatible with commercial (VXI Plug & Play) test development environments.

DESCRIPTION: Automatic Test is essentially a service provided by a computer connected to one or more test instruments. When a device is broken, the Automatic Test System (ATS) is connected to the device, and a Test Program Set (TPS) program developed to test and diagnose failures on that device is executed on the computer. The TPS tells the instruments what kind of signals, power, etc. to input to the device and what signals to measure. Based on the measurements made, the TPS is suppose to determine what needs to be repaired or replaced on the device being tested.

The problem with Automatic Test programming is that it tends to be much more complex than "regular" programming. When programming for PCs, the computer industry has well established standards so that software does not have to care who made a sound card or a CD drive. In ATS programming, the commands sent to similar instruments to stimulate or measure are usually not the same, if the instruments were made by different manufacturers. This means that every time an ATS is upgraded with new instruments, all the TPSs may need to be modified. The test industry is just now coming out with standards that will fix this, so that there will be less dependency between the TPS and the instruments on the tester. These standards will essentially "decouple" the TPS from the ATS configuration. Such standards will enable the DoD to save billions of dollars that would have been required to modify or rehost TPSs.

Another aspect of TPS programming that makes it more complex is that in most DoD generated TPSs, the diagnostics are part of the TPS. What this means is that the TPS has decision points based on which tests passed or failed, to try to narrow down to one or a few components where the product has a fault and needs repair. Putting these decision points in the TPS makes the TPS very complex, driving up their development and maintenance costs. If a test instrument is changed or not available, the product modified, or if it is learned that the original TPS held some decision paths that were not correct, the TPS would need to be modified. With the convoluted decision paths in a TPS, this is not an inexpensive or error free process. What is needed is a way to "decouple" the tests from the diagnostics, so that simple TPS tests can be executed with the decision logic in a separate program. Another benefit from this decoupling is that different diagnostic approaches can be used: decision trees, fuzzy logic, neural networks, etc.; whatever is most effective. The TPS tests would also be smaller and more modular, so that a change in one test is much less likely to cause errors to propagate through the rest of the program.

AI-ESTATE is the only industry standard that has been developed to address this expensive problem of diagnostics being embedded with TPSs. There are proprietary diagnostic test products available, but their unique data formats and software interfaces essentially lock the user into one way of doing things. With the DoD actively moving towards open system architectures in commercial products (primarily to avoid being locked into certain products and to allow flexibility in implementation), prototyping and creating an AI-ESTATE diagnostic tool is a natural extension of this policy into the problems associated with diagnositics and Automatic Test.

PHASE I: Research and develop an approach to integrate a diagnostic reasoner capability, based on AI-ESTATE standards, into a mainstream commercial test programming environment. Contractor will develop the system specification for the diagnostic reasoner. The reasoner must be capable of interfacing and interoperating with LabView, LabWindows and/or HPVEE. This may require establishing agreements with the manufacturers of these tools to enable modifications to accommodate a true AI-ESTATE compliant interface. The reasoner must be compliant with IEEE standards 1232, 1232.1 and P1232.2. If IEEE 1232.2 is not yet published as an IEEE standard the reasoner must be compliant with the most current draft available from the standards development group. The reasoner must be extendible to enable the addition of new diagnostic models, including the use of neural networks and fuzzy logic. The reasoner must have a graphical interface compatible with VXI Plug & Play and industry standards, to ensure the interface is intuitive and has a reduced learning curve to begin application. The reasoner will have a model development environment enabling the development, modification and maintenance of the diagnostic models. The environment shall preferably be implemented via Commercial Off-The-Shelf (COTS) tools such as Visual Basic or Visual C++.

A LabView or LabWindows prototype of the reasoner will be demonstrated with a test program of medium complexity; the Test Program Sets (TPS) may be based on an existing test program modified for the demonstration. The intent of the demonstration is to validate the "look and feel" of the reasoner interface; therefore it does not have to be a full implementation of the AI-ESTATE services.

PHASE II:

1.) Produce a working tool:

a. Develop a diagnostic reasoner with full implementation of the AI-ESTATE standards. The contractor should be able to show direct traceability of the reasoner services and exchange formats to the AI-ESTATE standards.

b. The contractor will participate in IEEE SCC-20 AI-ESTATE meetings to promote feedback from the AI-ESTATE standards group

on the utility and suitability of the tool.
c. The contractor shall provide suitable documentation for the use of the tool.
d. The contractor shall demonstrate the tool on LabView, LabWindows and/or HPVEE TPSs, exercising the tool sufficiently to prove that it provides the functionality required by the AI-ESTATE standard.
e. The contractor shall allow incremental releases of the tool to the government for review and feedback on its interface and capabilities.

PHASE III DUAL USE APPLICATIONS: This test tool has the potential of greatly increasing the flexibility of the test program developer, by extracting the diagnostics from the test program into a separate diagnostic reasoner. This capability greatly reduces the complexity of the test program, enables greater reuse of test program modules, and enables growth of a test program's diagnostic capability through enhancements of the reasoner model rather than modifying the test program.

RELATED REFERENCES:
1. IEEE 1232 - Artificial Intelligence Exchange and Service Tie to All Test Environments
2. (AI-ESTATE) - Overview and Architecture
IEEE 1232.1 - Artificial Intelligence Exchange and Service Tie to All Test Environments
3. (AI-ESTATE) - Data and Knowledge Specification
IEEE P1232.2 - Artificial Intelligence Exchange and Service Tie to All Test Environments
4. (AI-ESTATE) - Service Specification
Orlidge, Leslie A, An Overview of IEEE P1232 AI-ESTATE: The Standard for Intelligent Reasoning Based Systems Test and Diagnosis Arrives, AUTOTESTCON 1996 Proceedings,1996
Maguire, Richard J. and Sheppard, John W., Application Scenarios for AI-ESTATE Services, AUTOTESTCON 1996 Proceedings, 1996
Bowman, Gregory P., Diagnostic Reasoning Systems Data Representation: IEEE 1232.1 Artificial Intelligence Tie to Automatic Test Equipment (AI-ESTATE) Data and Knowledge Standard

AF98-253 TITLE: A Broad Based Environment for Test (ABBET) Architecture Prototype

CATEGORY: Engineering Development; Computing and Software

OBJECTIVE: Develop an implementation of the IEEE 1226 ABBET architecture, which will be able to work across multiple test development environments.

DESCRIPTION: The Department of Defense (DoD) currently uses hundreds of different types of Automatic Test Systems (ATS), each form of which is unique enough that Test Program Sets (TPSs) developed for one ATS is not executable on another. The uniqueness of the different ATS is primarily due to proprietary interfaces and information formats, as well as implementation specific instrument configurations. It is these features that make the costs of developing, maintaining, reusing and re-hosting TPSs difficult and very expensive. The IEEE standard 1226, ABBET, was developed to reduce the cost of automatic test by defining industry standard interfaces, services and information formats to eliminate the incompatibilities between different ATS and to foster the reuse of test code and information. This Small Business Innovative Research program is needed to translate the ABBET standard test architecture into a compliant and usable TPS development and execution environment.

PHASE I: Develop a signal class interface definition and model based on the 1226 Foundation Class hierarchy. Define signal models and interfaces to all required test properties. It is expected that the developer will borrow significantly from the IEEE ATLAS signal model, including the work being performed to develop the ATLAS 2000 language standard. Develop a specification for the ATS resident software and interfaces that would need to be developed/modified to demonstrate the ABBET architecture.

PHASE II: Define and code signal objects identified in Phase I. Design, code, test and demonstrate the class library in a commercial test development environment. Demonstrate test library extendibility, so that new classes can be integrated in. The demonstration software must be accessible to DoD participating organizations to enable active feedback. Integrate the ABBET compliant environment onto a representative VXI test system and onto a representative DoD ATS (to be identified and supported by the DoD). Demonstrate reuse of TPS objects between the test systems. Demonstrate TPS stability during instrument configuration changes.

PHASE III DUAL USE APPLICATIONS: ABBET promotes the development of commercial software tools as well as the use of existing off-the shelf tools.

REFERENCES:
DoD Acquisition Policy Document 5000.2R
IEEE ABBET Trial-Use Standard for A Broad-Based Environment for Test (ABBET) Overview and Architecture Draft 16.0 April 11, 1996
AUTOTESTCON '96 Proceedings

AF98-254 TITLE: Ergonomic Assist Device for Water Blast Gun Manipulation

CATEGORY: BASIC RESEARCH; Human Systems Interface

OBJECTIVE: Develop an assist device to improve the ergonomics of medium pressure water blast paint stripping.

DESCRIPTION: Medium pressure (15,000 psi) water blasting promises to be a viable technology for aircraft paint stripping. Production implementation has been difficult due to the weight, thrust, and possibly the configuration of the blast gun. These issues make it difficult for workers to handle the blast gun for more than a small portion of their eight-hour shift. An alternative configuration to the original design of the blast gun has been prototyped here at OC-ALC and has been fairly successful for stripping the upper side of horizontal surfaces. The challenge is to develop a device that will provide good ergonomic configuration, while reducing the weight and thrust to a level that would be comfortable for an eight-hour shift for blasting aircraft surfaces.

PHASE I: Research and/or design ergonomic assist devices for heavy tool manipulation. Investigate the feasibility on the basis of cost, reliability, ease of use, and mobility on or around large aircraft. The end item would be a lab prototype that demonstrates the feasibility of the Phase II working prototype.

PHASE II: Refine the Phase I device into a working prototype that can be used in a production environment.

PHASE III DUAL USE APPLICATIONS: May be used by private sector aerospace maintenance companies or any medium/high pressure water or other abrasive blasting operations.

AF98-255 TITLE: Turbine Oil Condition Monitoring by Raman Spectrometry

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop a method to assess the viability of Raman spectroscopy as an analytical technique for monitoring the condition of in-use synthetic turbine oils.

DESCRIPTION: Current oil condition monitoring methodologies fall into two major categories: (A) Atomic Emission Spectroscopy (AES) for particulate wear metal analysis and (B) physical properties testing. AES is a well established, fast and reliable technique, well suited for field deployment. Physical properties testing such as flash point, viscosity, density, fuel dilution, water, and total acid number requires time, varied laboratory apparatus and reagents, trained technicians, and off-line analysis. Recent developments (1,2,3) in Fourier Transform Infrared Spectroscopy (FT-IR) have made many aspects of oil condition monitoring as quick and easy as AES. Problems and limitations such as insensitivity to low water levels and solvent usage still exist and should be addressed in this effort to advance the Raman analytical technology. Recent technological advances in holographic filters and gratings, Charge Couple Device (CCD) detectors, and diode pumped lasers (4,5,6) have made Raman spectroscopic measurements routine and convenient. The availability of commercial off-the-shelf process monitors (7) based on Raman spectroscopy indicates that alternatives to FT-IR and physical properties testing of turbine oil condition may be feasible. An in-situ Raman spectroscopy-based system with no moving parts, the capability of sampling through containers, transparent access ports, or via fiber optics, and measurements of vibrational frequencies that depend on different selection rules than FT-IR could advance oil condition monitoring technology. The Raman technique can utilize either an interferometer (FT-Raman) with a moving mirror or a dispersive holographic transmission grating (8) with no moving parts. This research should include but not be limited to (a) investigations of turbine oil Raman emissions with emphasis on laser wavelength selection to maximize response and minimize fluorescence, (b) correlation of FT-IR frequency bands of interest with Raman emission lines [hydrogen bonded O-H, free O-H, single bridge O-H, C-O, C=O, C-O-C, P-O, S-O, and N-O vibrational frequency correlations], (c) laser power stabilization, (d) laser wavelength stabilization (mode hopping) (9), (e) spectrometer wavelength calibration - Raman shift scale (10,11,12), (f) CCD A/D intensity calibration (g), sampling geometry (direct coupling vs. fiber optics), (h) spectrometer design: interferometer vs. grating instrument.

PHASE I: Assess the viability of Raman spectroscopy as an analytical technique for monitoring the condition of in-use turbine oils. Assessment of spectrometer types, lasers, CCD detectors, sampling geometries, and Raman emission frequencies specific to synthetic turbine oils, and detection levels of contaminants and breakdown products will be accomplished.

PHASE II: Upon successful demonstration of Raman spectroscopy as a sensitive and effective detection system for the condition of jet turbine oils, Phase II will develop and integrate a prototype in-situ analyzer system and use it to make measurements on in-use turbine oils and establish a database for an oil condition model. The final product will be an advanced physiochemical model of in-use oil condition and sensor specifications for the production of a field deployable instrument. The Raman model shall be correlated with the current state-of-the-art spectroscopy (FT-IR) system and physical properties testing.

PHASE III DUAL USE APPLICATIONS: A market currently exists within the Department of Defense. The potential for deployment into the private sector is likely for industries such as refining, lubricant blending, railroad, trucking and other transportation concerns, large mobile equipment manufacturers, and the airline industry where oil condition/composition is critical to operations.

REFERENCES:

1. Toms,A., Final Report, "BIO-RAD FTS7 Fourier Transform Infrared (FT- IR)". Report #: JOAP-TSC-TR-95-01, November 23, 1994
2. Powell, J., Compton, D., "Automated FTIR Spectrometry for Monitoring Hydrocarbon-Based Engine Oils", Lubr. Eng., 49(3), pp.233-239, (1993).
3. Coates, J., Setti, L., "Infrared Spectroscopy as a Tool for Monitoring Oil Degradation", Aspects of Lubricant Oxidation, ASTM Special Technical Publication 916, Stadtmiller, W., Smith, A., eds., Am Soc. Test & Mat., (1984).
4. Kim, M., Owen, H., Carey, P., "High-Performance Raman Spectroscopic System Based on a Single Spectrograph, CCD, Notch Filters, and a Kr+ Laser Ranging from the Near-IR to Near-UV Regions", Applied Spectroscopy, 47(11), 1780 (1993).
5. Yang, Morris, Owen, " Holographic Notch Filter for Low-Wavenumber Stokes and Anti-Stokes Raman Spectroscopy", Applied Spectroscopy, 45(11), 1533 (1992).

AF98-256 TITLE: Develop a Sensor for Monitoring Aircraft Batteries

CATEGORY: Engineering Development; Electronics

OBJECTIVE: Develop a non-intrusive sensor for recording critical parameters needed for calculating aircraft battery reliability.

DESCRIPTION: An innovative sensor is needed to sense and record the true operating conditions and environment for aircraft batteries. A "smart" sensor containing a micro-processor and memory, is needed to sample and record data on board operational military aircraft. The sensor will be used primarily on maintenance free batteries. Data collected by the sensor will be used to calculate battery reliability, remaining useful life, and for fault analyses when aircraft batteries or chargers fail. The sensor will provide Air Force engineers and equipment managers the needed data for determining when to replace defective or depleted batteries. Factors having the greatest effect on battery reliability are: a. Operating time; b. Number of charge/discharge cycles; c. Number and severity (depth) of discharge cycles; d. Length of time in a deep discharge condition before recharge; and, e. Temperature. The sensor will contain micro-electronic devices to sample and record critical battery parameters. The sensor will be small, self-contained, rugged, and have it's own battery. It must be designed so that minimal modification to the battery or charger is required for installation. The sensor must be flight qualified and must have no impact to aircraft safety, and no interference on battery system performance. The sensor will contain non-volatile memory sufficient to record 1000 hours or more of data, and will have the capability for the data to be down-loaded and analyzed with a commercial offf-the-shelf laptop computer. Software will be developed or obtained for the laptop computer that will enable the user to review the data collected by the sensor, and perform reliability analyses of the data.

PHASE I: Define operational requirements of the sensor and the software. The sensor circuitry will be designed and a breadboard design constructed and demonstrated. A software flowchart will be developed to define the analysis approach and scope of the proposed software. Commercially available software will be used where possible.

PHASE II: Prototype sensors will be built and tested. Engineering data for the sensor design will be delivered. The laptop computer software will be developed and demonstrated. The software and user's manuals will be delivered.

PHASE III DUAL USE APPLICATIONS: The battery sensor has a high potential for dual use commercialization. Any vehicle or device containing storage batteries could use this sensor for determining battery life. The sensor will be very useful to commercial aircraft as well as electric automobiles.

REFERENCES:

1. P. Bro and S. C. Levy, Quality and Reliability Methods for Primary Batteries, John Wiley & Sons, Inc., 1990.
2. Technical Staff of Gates Energy Products, Rechargeable Battery Applications Handbook, Butterworth-Heinemann, 1992.

AF98-257 TITLE: Robust Batteryless Power Backup for Critical Power Applications

CATEGORY: Engineering Development; Command, Control, and Communications (C3)

OBJECTIVE: Develop robust, deployable, cost-effective alternatives to battery-based energy storage sources using flywheel technology.

DESCRIPTION: Alternative energy sources are needed to supplement and replace battery backup Uninterruptible Power Supplies (UPS) for critical deployed systems and other rugged field environments. Recent advances in high power electronics, new magnetic bearings, and technological research in composite materials have revolutionized the capabilities of flywheel based energy storage systems. These breakthroughs have enabled numerous small businesses to start development of smaller, faster, and more efficient (approaching 90%) flywheel energy storage systems. All communication, command and control, radar, and information systems contain sensitive electronic equipment which must be protected against power quality problems. With deployable equipment, the shelter manufacturing facilities have incorporated UPS and batteries to increase power reliability to the sensitive electronic equipment. After manufacturing, these shelters are scattered to different military units in all corners of the world. They sit waiting to be deployed in support of the US military and NATO forces. The type of UPS used in these shelters must withstand long periods of no charge, be able to charge fully in a timely manner, and be able to function in a wide variety of temperatures and climates. Permanent facilities located in harsh environments also must be provided quality power. With all of this in mind, alternatives to battery-based UPS must be developed and tested. Most power quality problems last less than 30 seconds, which is the maximum time it takes to get a "fast start" backup generator on line. A capability to carry through short term power sags and outages, as well a capability to hold a load until a generator can come on line, is needed. A Flywheel based UPS is one alternative that appears extremely promising. This topic seeks innovative approaches relating to fielding of flywheel based UPS in adverse environments. Special considerations will be expected for fielding these units in extreme heat and/or cold. There are no adverse environmental impacts and no special cooling requirements with this technology. The issue is whether these types of UPS can be cost effective and provide efficient power.

PHASE I: Build a prototype unit and complete a conceptual design package for integration into an existing site.

PHASE II: Fabricate, install, integrate, test, and monitor the prototype unit at an existing site.

PHASE III DUAL USE APPLICATIONS: National Weather Service radar installations, Federal Aviation Administration facilities, computer chip manufacturing companies, assembly lines, utility companies, and commercial power quality experts have all expressed interest in improving power quality.

REFERENCES:
1. Weaver, E.J., "Dynamic Energy Storage System," Paper presented at Power Quality Solutions/Alternative Energy Conference, Sep 96, pp 373-380.
2. Balachandra, J., et al, "Emerging Technologies in Uninterruptible Power Supply Systems," Paper presented at IASTED International Conference, 6-8 Jun 96, Banff, Canada.

AF98-258 TITLE: In Situ Remediation of Polychlorinated Biphenyls (PCBs) in Soils

CATEGORY: BASIC RESEARCH; Environmental Quality/Civil Engineering

OBJECTIVE: Develop an innovative in situ process to clean up PCBs contained in soils.

DESCRIPTION: Polychlorinated biphenyls were used in various industrial applications over the years. As a result of these industrial uses, PCBs have contaminated soils throughout the world. The only currently available technologies to remove PCBs from contaminated soils require that the soils be excavated for processing. This can be an expensive and time consuming process. Research into in situ technologies for PCB clean up has been progressing in past years, but has not been successfully implemented in the field. A challenge to developing in situ processes is that PCB-contaminated soils can also contain other contaminants such as volatile organic compounds, semi-volatile organic compounds, and other hazardous compounds. An in situ PCB clean up process could provide a cost-effective alternative to current ex situ processes.

PHASE I: Advance research in the area of in situ remediation of highly chlorinated PCBs. Complete laboratory scale research on in situ degradation of PCBs in contaminated soils. Prepare technical approach for continuation of basic research to bench-scale and field-scale including "proof of concept" at laboratory scale. The end point of the advanced research should be to develop in situ processes capable of reducing PCB concentrations in soils from levels greater than 10,000 mg/kg to less than 10 mg/kg.

PHASE II: Continue development of in situ PCB clean up processes. Conduct bench-scale "proof of concept" experiments. Continue development with small field-scale demonstration of in situ PCB clean up processes for soils.

PHASE III DUAL USE APPLICATIONS: Technology could be applicable to pollution control and environmental clean up.

REFERENCES:
1. Abramowicz, D.A. 1990. "Aerobic and Anaerobic Biodegredation of PCBs: A Review." CRC Critical Reviews in Biotechnology, Vol. 10, Issue 3. pp. 241-251.
2. Higson, Frank K. 1992. "Microbial Degradation of Biphenyl and Its Derivatives." Advances in Applied Microbiology. Volume 37, pp. 135-165.

AF98-259 TITLE: <u>Composite Repair/Manufacturing Techniques Utilizing Ultraviolet (UV) Hardenable Resins</u>

CATEGORY: Engineering Development; Environmental Quality/Civil Engineering

OBJECTIVE: Develop UV hardenable or other unique resins for use in field repair/manufacture of complex parts for composite shelters.

DESCRIPTION: Composite materials offer increased strength, longer life and less weight for lower cost for Department of Defense (DoD) tactical shelter applications than do the conventional metal counterparts. Currently the Air Force has approximately 4800 shelters in the field. Eventually, composite shelters will replace all of those units. Cost benefits due to the use of composite materials on the Air Force units, not inclusive of the other DoD agencies, is estimated at $3.1M per year. The composite materials however often require major equipment investments to produce a material of high strength and durability. This can include anything from autoclaves for curing of binders to pultrusion presses. For large or complicated parts, equipment investment or availability frequently limits the application of composites. In addition, composite shelters do not lend themselves to the same repair techniques as do the metal shelters, and autoclaves do not exist in the field. A requirement exists for ultraviolet hardenable or other unique resins which may be mixed with either graphite, glass or metal fibers and applied in the field. The same process should also be capable of producing complex parts in a manufacturing environment without major or unique equipment. The resultant material and bond to the existing composite should be equivalent in properties to the original material. Application to both E-glass and graphite fiber pultruded composites should be considered.

PHASE I: Develop concept for field repair for pultruded panels and manufacture of E-glass and graphite composites utilizing UV hardenable binders. Determine material availability, environmental restrictions, storage requirements and general handling requirements/limitations and structural properties for the concept. Cost estimates should be provided for repair and manufacture analysis.

PHASE II: Demonstrate application of the UV binder for repair and manufacture of composite panels/components. Material property analyses will be required, demonstrating ease of application, bond and material strength and integrity for application to International Standardizion Organization (ISO) shelters.

PHASE III DUAL USE APPLICATIONS: Commercially the Air Force ISO shelter equivalent is the cargo container. Reportedly, the world fleet for cargo containers is almost 8M units and has a life expectancy of less than ten years. Composite materials offer a definite advantage over the heavier metal units and will eventually overtake the market. An effective repair/manufacture technique will be a major factor in the rate of implementation.

AF98-260 TITLE: <u>Fault Set for Bussed Components</u>

CATEGORY: BASIC RESEARCH; Environmental Quality/Civil Engineering

OBJECTIVE: Develop an approach to improve failure detection capability when components are bussed together or in closed-loop circuits.

DESCRIPTION: Newly developed and future generations of avionics and electronic equipment planned for use in Air Force applications will be significantly more complex then present systems, and rely exclusively on existing test software methods for repair. Current test software methods for fault set determination are precluded when components are bussed together or exist in a closed-loop circuit. As a consequence, fault sets can be greater than ten components with no specific logic as to the most probable cause of failure. So, the pick and change technique is used until the defective component is found. Alternative methods or algorithms

including sensor-fusing are needed to aid in the determination of defective components when components are bussed together or exist within a closed-loop. Additional algorithmic or software techniques are needed to augment or replace existing fault isolation techniques.

PHASE I: Identify and assess candidate technologies and approaches for improving fault isolation in bussed and closed-loop circuits. Recommendations will be provided as to the potential usefulness of these technologies in specific application areas.

PHASE II: Investigation into the most promising technologies and approaches will be made, including the design and prototype development of experimental applications to evaluate their effectiveness.

PHASE III DUAL USE APPLICATIONS: Successful results of this topic can be applied to improving fault isolation in numerous commerical and industrial test and process control applications.

REFERENCE: Kirkland, L.V. "ATE Enabling Technologies", AUTOTESTCON 94' Anaheim, California, 21-24 September, 1994. (Personal paper by Mr. Kirkland, attached)

AF98-261 TITLE: Multiplexed Real-Time Opacity Monitor

CATEGORY: Engineering Development; Environmental Quality/Civil Engineering

OBJECTIVE: Develop an Environmental Protection Agency (EPA) approved opacity monitor for industrial processes.

DESCRIPTION: The new Clean Air Act Amendments require opacity monitoring for Air Force processes which produce particulate (smoke) emissions such as boilers, maintenance operations, generators, etc. Currently, the only acceptable approach to these measurements is to use expensive, manpower intensive commercial opacity meters or EPA Method 9 ("Visual Determination of the Opacity of Emissions from Stationary Sources"). This method relies on specially trained personnel who must be certified every six months at an approved "smoke school." To obviate the need for this "calibrated eyeball" approach, there is a need for an instrumental approach. There are existing opacity monitors which rely on visual light attenuation. These monitors are costly ($10-$20K each) and must be installed on individual sources. This project seeks an instrument which would have many small measurement heads linked to a central processing unit. This would allow placement of these measurement heads at individual emission points, but provide a central data acquisition and reporting station. The goal would be to provide a cost-effective, lower-maintenance method to meet opacity measurement requirements.

PHASE I: Demonstrate a bench-scale unit which can monitor opacity--in a laboratory setting--from two separate sources using a measurement head at each source controlled by a single central processor unit. Measurements must meet current EPA opacity monitoring standards.

PHASE II: Engineer a field-scale unit with at least four measurement heads and demonstrate that it produces near-real-time opacity measurements from emissions at a field test site. Again, these measurements must meet current EPA opacity monitoring standards.

PHASE III DUAL USE APPLICATIONS: This technology has equal potential application to the measurement of any industrial emission source, whether from government or industry. Therefore, the contractor could expect to have full dual-use benefits from his efforts. Further, there are significant international opportunities since many other countries have opacity regulations.

REFERENCES: Larose, G., Leclerc, B., Fougeres, A., et al. "Industrial implementation of lidar systems using compact solid-state lasers," in Proceedings of the 1996 A&WMA International Symposium on Optical Remote Sensing for Environmental and Process Monitoring, VIP-55, Air & Waste Management Association, Pittsburgh, 1996, pp. 276-281.

AF98-262 TITLE: Statistical Control Process Application to Test Failure Information

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a method to apply statistical control process techniques to view and interpret equipment test failure data.

DESCRIPTION: Significant changes in the performance of equipment may occur as a result of aging and other factors within weapon systems and their associated support equipment. Current methods do not allow for the effects of these factors in the determination of equipment performance tolerances or test limits, resulting in apparent and actual decreases in equipment readiness and test program

precision. New methods must be created to detect and compensate for this degradation in performance. Statistical control processes can be used in detecting statistically significant trends in test failure data that can aid in forecasting equipment aging problems and test limits. Artificial intelligence techniques can be used to acquire knowledge and supplement technician capabilities in test and maintenance applications. This topic focuses on research and exploratory development of the combination of statistical processes and AI technologies to effect a problem solution. Of particular interest are solutions which capitalize on the ability of statistical control processes to detect significant trends in failure data, and the ability of AI-based technologies to capture these trend data and provide information for engineers to determine their significance and application to the domain.

PHASE I: Focus on identifying appropriate statistical and AI processes and developing one or more methods that will demonstrate their effectiveness during Phase II. Detailed design and evaluation criteria for each method will be developed.

PHASE II: Methods defined during Phase I will be developed, demonstrated and evaluated.

PHASE III DUAL USE APPLICATIONS: Provides capitalization on the ability of statistical control processes to detect significant trends in failure data, and the ability of AI-based technologies to capture these trend data and determine their significance and application to the domain. Significant commercial markets exist for this technology in industrial process control and medical process applications.

REFERENCES:
1. Kirkland, L.V., "ATE Enabling Technologies", AUTOTESTCON 94' Anaheim, California, 21-24 September, 1994.
2. Levesque, Mario J, NAVAL POSTGRADUATE SCHOOL MONTEREY CA, " Fault Detection and Isolation for the Bluebird Test Bed Aircraft," Dec 1993, Master's thesis.

AF98-263 TITLE: Non-Destructive Inspection (NDI) of Cracks, Corrosion, etc. in Second and Third Layer Materials Around Fastener Holes

CATEGORY: EXPLORATORY DEVELOPMENT; Materials, Processes and Structures

OBJECTIVE: Develop a system, process, tool, etc. by which fatigue cracks, corrosion, etc. can be detected in underlying structure (i.e., not directly accessible from the surface) around fastener holes without disassembling or removing the fastener.

DESCRIPTION: Current methods for inspecting second and third layer structures are either site specific, requiring engineering development for each application, or require the removal of the fastener for a bolt-hole eddy current check. A generic process is required that will allow a wide variety of underlying structures to be inspected without removing the fastener. In general, metallic (ferrous and non-ferrous) and composite materials require inspection. Material thickness may vary within the structure to be inspected. The overall thickness of any structure will generally be within 0.4 to 2 inches. The method to be employed should allow inspection of the aircraft without-disassembly. Preferably, the wings and empanage will be inspected from the outside surface. Any equipment/process should meet applicable fire and safety codes. Wing station 405 on the C-141 aircraft is an excellent example of a multiple layer structure requiring inspection. Research and development is necessary to develop this detection tool.

PHASE I: Assess the feasibility of various concepts for second and third layer damage detection. Demonstrate one or more methods in a breadboard or brassboard model.

PHASE II: A portable, prototype version will be demonstrated with Warner Robins Air Logistic Center (WR-ALC) weapon systems at the UNCLASSIFIED level. The system will then be demonstrated in a field level application.

PHASE III DUAL USE APPLICATIONS: Successful development would lead to world-wide marketability in both aerospace and non-aerospace applications. For example, civilian airlines have inspection requirements similar to the Air Force. In addition, technologies are being sought to perform inspections of America's transportation infrastructure including automotive and train bridges.

REFERENCES:
1. Technical Order (T.O.) #33B-1-1, Nondestructive Inspection Methods.
2. Rose, James H., "Nondestructive Detection and Characterization of Corrosion in Aircraft," Nov 1996, DTIC #AD-A318 667.
3. Sheppard, William R., "Eddy Current for Detecting Second Layer Cracks Under Installed Fasteners," Apr 1994, DTIC #AD-A282 412.
4. Buckhardt, Gary L., "Eddy Current for Detecting Second-Layer Cracks Under Installed Fasteners," Feb 1997, DTIC #AD-A279 871.

AF98-264 TITLE: Surface Mapping System for Complex Weapon System Components

CATEGORY: Engineering Development; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop a system for capturing the surface geometry of complex aircraft components and expand this data into tool paths for numerically controlled machines.

DESCRIPTION: A portion of the work performed at Warner Robins Air Logistics Center (WR-ALC) is the manufacturing of parts and components for military aircraft. Some of the most complex parts are five-axis structural components. The surface geometry of these parts contains volumetric features such as slots, steps, blind holes, irregular cavities, bosses, protrusions, notches, and multiple edges. Production of these components is accomplished on Computer Numerically Controlled (CNC) machines. Prior to the machining process, a part program must be developed. This part program is created by developing a Computer Aided Design (CAD) surface or solid model from paper drawings. From this model, CNC tool paths are generated using Computer Aided Manufacturing (CAM) software. The development of the solid model is an extensive and time consuming process. In some cases, an existing aircraft component can be obtained for inspection. Current technology is available to digitize (create the model) simple components through the use of a coordinate measuring machine, x-ray computed tomography, and laser scanning. These methods, however, are unable to create a model for complex, five-axis structural components. If these methods could be expanded, or a new approach was developed to accomplish this task, the time required for model production of complex parts would be greatly reduced. The intent of this research and development effort is to develop a system capable of digitizing the surfaces of an actual aircraft component and creating a digital CAD model from it. This process would not require the use of engineering drawings or loft data. After creation of the CAD model, the system will coordinate with the CAM software currently in place at WR-ALC to generate tool paths for the CNC machines. The developed system must allow design changes to be made to the CAD model prior to generating the tool paths. This research effort is intended to reduce the time required to generate part programs for the CNC machines at WR-ALC, resulting in a process measured in terms of "days" instead of "weeks and months" as currently required.

PHASE I: Assess the feasibility of designing a system or machine that is capable of capturing the surface geometry of complex aircraft components and can subsequently generate a solid CAD model. Perform preliminary laboratory testing of this proposed system, and provide results of this test to WR-ALC.

PHASE II: Perform research and development of the design concept, including all hardware and software necessary for operation. Deliver the system prototype(s) to WR-ALC, and demonstrate the ability of the system to develop surface models, interact with the CAM system, and manufacture an acceptable aircraft component on a CNC machine.

PHASE III DUAL USE APPLICATIONS: The Surface Mapping System developed under this program will have extensive civilian and military applications. The private sector has researched and developed systems comparable to this in the past, but technology was not advanced enough to handle complicated components.

REFERENCES: "Re-engineering Components Using Laser Scanning," Concurrent Technologies Corporation (CTC), 1994

AF98-265 TITLE: Advanced Corrosion Life Prediction Tool

CATEGORY: BASIC RESEARCH; Modeling and Simulation (M&S)

OBJECTIVE: Develop an accurate method/tool for predicting the residual life of a corroded aircraft part.

DESCRIPTION: The annual cost of corrosion to the US Air Force is over one billion dollars. Corrosion is often the number one maintenance problem on older aircraft like the C-130. Both primary and secondary structures are susceptible to various types of corrosion, stress corrosion cracking, and corrosion-initiated fatigue. Older model aircraft that are stationed near coastal areas are very corrosion prone, which results in costly repairs and frequent preventive maintenance actions. An advanced corrosion life prediction method/tool would reveal the remaining life of corroded components, eliminating unnecessary repairs and component replacements and increasing both aircraft availability and mission readiness. In addition, many aircraft components currently do not have grindout limits, which define the amount of material that is allowed to be removed before repair/replacement. If these grindout limits were accurately determined, needless replacements could be avoided.

PHASE I: Assess the feasibility of developing a method and/or software tool to predict the remaining life of corroded metallic aircraft parts, as well as determine grindout limits. This method/tool would integrate with existing Technical Order data and have the ability to track aircraft components.

PHASE II: Develop a prototype method/tool to predict the remaining life of corroded aircraft parts and determine grindout limits. Analyze corroded components and conduct validation experiments to verify the method/tool can accurately predict

component life and track aircraft components. Test the method/tool in the field. Deliver a final report and preliminary version of the prediction/tracking software.

PHASE III DUAL USE APPLICATIONS: An advanced corrosion prediction method/tool could be used by all branches of the Department of Defense (DoD), as well as by commercial airlines, to better determine repair intervals for aircraft parts -- even if they do not show signs of corrosion. In addition, this same tool could be used in the automotive and boating industries. This technology could also influence the future design of vehicle materials and components to be more corrosion resistant.

REFERENCES:

1. T.O. 1C-130A-3 (C-130 Repair manual)
2. Smith, E.J., "C-130 Structural Repair/Corrosion Tracking and Corrosion Prediction Program", Dec 1988.
3. Lockheed-Georgia Co, "Predictive Corrosion Modeling, Volume 1," DTIC AD-A191 229

AF98-266 TITLE: Conversion Process for Legacy Stable Based Printed Circuit Board Artwork

CATEGORY: Engineering Development; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop and demonstrate a process and/or toolset to reliably and accurately convert legacy Printed Circuit Board (PCB) artwork into formats interpretable by computer numerically controlled machines.

DESCRIPTION: Master PCB artwork for Air Force weapons systems and commodities have traditionally been delivered on mylar. The reproduction costs for these "stable based" documents exceed $400 per sheet, and in many cases this data must be digitally captured before it is usable in the production process. In addition, this material requires a controlled environment for storage and degrades with usage over time. A reliable process needs to be developed which can digitize the mylar-based PCB artwork and convert the resulting digital data into a format acceptable to computer numerically controlled machines for creating PCBs. This format would likely be a Gerber plot file and/or IPC-350. This process and/or toolset should also support the reproduction of mylar-based output, using a calibrated plotting device. The process and/or toolset shall be developed using Commercial Off The Shelf (COTS) tools and equipment whenever possible.

PHASE I: Assess feasibility of proposed solution. Assessment should address the following: user requirements, including tolerances, uses, etc., identification of candidates for COTS equipment and software, identification and documentation of all required software/hardware integration.

PHASE II: Research, develop, and demonstrate a detailed conversion process and/or toolset and thoroughly evaluate results. Process will be validated by converting a representative sample of PCB artwork managed by WR-ALC/TIL. This digital data will be further validated using production manufacturing equipment at WR-ALC and an external vendor (preferably a small business).

PHASE III DUAL USE APPLICATIONS: All Department of Defense (DoD) agencies, and much of industry, face similar challenges in increasing the usability of PCB artwork stored on stable based media. A reliable process to digitize this material would have an extremely broad application.

AF98-267 TITLE: Global Positioning System (GPS) Satellite 3-D Visualization and Blanketing Tool

CATEGORY: Engineering Development; Modeling and Simulation (M&S)

OBJECTIVE: Develop techniques to integrate 3-D terrain mapping data with a GPS satellite constellation simulator.

DESCRIPTION: A visualization tool is required that will modify and create simulator files for the GPS Environmental Simulator located in the GPS User Equipment (UE) Integrated Support Facility (ISF). In particular, the tool will 1) determine loss of Satellite Vehicle (SV) signals due to terrain and/or Host Vehicle (HV) masking; 2) create a realistic, high resolution 3-D visualization of the generated simulation output data and the data from the GPS receiver under test (including visualization of the HV and its interaction with the SV and geographic worlds); 3) display and record scenarios for later playback; and 4) allow the user to view, in playback mode, the display from multiple view points with SV masking identified. Although some visualization tools currently exist in the market, none currently integrate visualization with real-time GPS simulation capabilities. Research and development is required to create a 3-D GPS satellite visualization and blanketing tool.

PHASE I: Develop and assess the feasibility of a preliminary design and integration plan that operates within the existing capabilities of the ISF environmental simulator.

PHASE II: Design and document new or modified software code. Construct test scenarios to be used in Phase II demonstrations. Deliver a functional prototype including any hardware/software developed. Demonstrate the visualization tool's compatibility and performance with the ISF environmental simulator and verify the above objectives are met. Plan for technology transition into potential commercial ventures.

PHASE III DUAL USE APPLICATIONS: The technology of integrating GPS and 3-D terrain mapping data has both commercial and military applications. This technology will enhance GPS user equipment problem duplication/analysis and GPS mission planning capabilities that support the warfighter. Dual-use applications include planning for airport runway approaches and determining beacon and precision lighting placement based on integrated GPS and terrain mapping information (especially useful in hilly or mountainous regions). This technology may also be used in agricultural applications to optimally position crops to optimize sun exposure due to terrain. Agencies associated with land management (e.g., habitat preservation of plants & animals) and parks and recreation would have many applications for this technology as well.

REFERENCES: To obtain these references, POC is Paula Conger, 912-926-7596, conger@jssmo.robins.af.mil.

1. Integrated Support Facility (ISF), WR-ALC/LKNE, "DRAFT Visualization and Blanketing Tool Performance Specification", Dec 1995.

2. Fowler, Jesse and Kelly, Don, "Integrated Support Facility Global Positioning System Visualization and Blanketing Tool" paper, Control Systems Research, Inc., March 1995.

AF98-268 TITLE: Environmentally Compliant Touch-up Process for Two-Component Paints

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop a cost-effective method for applying two-component coating materials to small areas.

DESCRIPTION: Aerosol or spray paints are a convenient, low-cost method of touching-up coatings in the field. However, these coatings are not as durable as the original coatings on the weapon system. Aerosol spray paints typically contain a single component lacquer or enamel, whereas the coatings on weapons systems are two-component epoxy and polyurethane paints. Areas needing only minor touch-up (0 to 3 square inches) are currently repaired using commercially available "Sempens." A paint touch-up process or coating needs to be researched and developed which offers the convenience of a spray can and the durability of a two-component coating for areas too large for use with Sempens. Repair areas of up to five square feet shall be addressed by this research and development effort.

PHASE I: Assess the feasibility of various concepts and demonstrate one or more concepts with conceptual model(s).

PHASE II: Develop a prototype and demonstrate it with all Department of Defense (DoD) coatings systems (unclassified). Coatings will be tested for adhesion, durability, etc., after application to ensure no change in properties.

PHASE III DUAL USE APPLICATIONS: Successful development would lead to world-wide marketability in both aerospace and non-aerospace applications. Commercial airlines would be one potential application as their coatings needs are similar to ours. The commercial potential in other areas would be much greater, to include any painted object potentially requiring touch-up. A short list might include automobiles, appliances, furniture, and building or construction applications. Remodeling and repair businesses would be major users.

REFERENCES: Technical Order (T.O.) #1-1-8, Application and Removal of Organic Coatings, Aerospace and Non-Aerospace.

AF98-269 TITLE: Next Generation Lubricant for Weapon Systems

CATEGORY: Basic Research; Electrotechnology and Fluidics

OBJECTIVE: Develop an improved high speed, high load lubricant for weapons systems operating in extremely fine grain sand environments.

DESCRIPTION: The problem with current weapon system lubricants was noted during the Persian Gulf War. The fine desert sand became entrapped in aircraft and helicopter guns. Particularly affected was the 20mm gun, the most commonly used aircraft gun in the DoD. Current semi-fluid lubricants, along with the all purpose grease used to pack bearings and gears, became completely fouled with sand after several days exposure, causing the weapons to malfunction. A Teflon-based lubricant, TW-25B, has since been tested as a possible solution to the problem. This lubricant may work in certain low speed applications; however, to maintain a high firing rate, the Teflon lubricant must be applied in quantities that would also attract large amounts of sand. A satisfactory solution has not yet been found for keeping weapon systems functioning properly in a sand environment. Current weapons system lubricants were developed decades ago and do not take advantage of new, environmentally sound technology.

PHASE I: Thoroughly examine current weapon lubricants and lubrication systems. Develop and assess the feasibility of preliminary design concepts for new lubricant. Select the most feasible alternative for development. Concept selected must not increase maintenance demands on troops and must not contain any hazardous materials.

PHASE II: Fully research, develop, produce and test the new lubricant in an actual 20mm system.

PHASE III DUAL USE APPLICATIONS: Next generation lubricants could be used throughout the DoD to extend the life of weapon system parts, lower maintenance costs, and improve gun performance in all environments. The entire DoD inventory of aircraft guns, ammunition handling systems, ammunition loaders, and bomb racks would also benefit. Furthermore, any vehicle that uses lubricants exposed to sand is potential beneficiary. Other commercial uses include the small arms industry, automobiles and transportation, and high speed industrial machinery.

REFERENCES:

1. Strahl, Gerald A., "M230 Gun Lubricant Evaluation Test," May 1995, DTIC #AD-B199 417.
2. Strahl, Gerald A., "M197 Lubricant Evaluation Test," Nov 1993, DTIC #AD-B205 195.

AF98-270 TITLE: Portable, Non-Damaging Depaint System for Removing Coatings from Small Areas

CATEGORY: EXPLORATORY DEVELOPMENT; Environmental Quality/Civil Engineering

OBJECTIVE: Develop a low-cost, environmentally compliant, hand-held system for non-damaging coatings removal.

DESCRIPTION: Field level maintenance personnel are required to depaint small areas of Air Force weapons systems, such as aircraft, to facilitate various maintenance and inspection procedures. Historically, methylene chloride based chemical paint removers have been used. Unfortunately, chemical paint removers that are environmentally compliant are not 100 percent effective with all Air Force paints. Mechanical removal methods for small areas are currently limited to hand sanding. A method to depaint small areas of aircraft and ground support equipment in a cost-effective, environmentally compliant manner is required. The coating systems involved are standard Department of Defense (DoD) paints and primers listed in Technical Order 1-1-8 | applied to aluminum, iron based metals, and composite substrates. This system/technology should be extremely portable--allowing one individual to transport it to an aircraft and use it for depainting. The process shall not damage aerospace materials listed above in thicknesses down to 0.016 inches and shall effectively remove all Air Force coating systems.

PHASE I: Assess feasibility, compare various concepts, and perform tests to validate a particular concept for full evaluation. A prototype may be developed and demonstrated in this phase.

PHASE II: Fully research and develop the depainting tool and manufacture a production prototype. Reliability, maintainability, evaluation of potential damage to aerospace materials, and cost-effectiveness of the developed technology shall be addressed/evaluated in this phase.

PHASE III DUAL USE APPLICATIONS: Private industry and other government agencies have both an aerospace and non-aerospace need for this process. There is a great potential for commercialization success if this project is successful in developing a viable technology. This technology would be useful in the commercial sector for small area paint removal for corrosion repair or non-destructive inspection. Applications would include automobiles, commercial and private aircraft, bridges, and ship/boat applications.

REFERENCES: Technical Order #-1-8, Application and Removal of Organic Coatings, Aerospace and Non-Aerospace.

AF98-271 TITLE: Subminiature Telemetry (SMT) Instrumentation

CATEGORY: Engineering Development; Electronics

OBJECTIVE: Develop Code Division Multiple Access (CDMA) spread spectrum technology for application in SMT instrumentation

DESCRIPTION: The ability to integrate SMT instrumentation into the inventory of munitions and/or fleet aircraft is vital to supporting future Air Force test missions. The best prospects for achieving this capability is through the development and application of CDMA spread spectrum technology. The CDMA SMT system consists of Integrated Telemetry Packages and Receiver Demodulator Units (RDUs). The foundation for this technology has been initially developed and tested under Department of Defense (DoD) Test Technology Development & Demonstration funding, and managed by the Wright Laboratories Munitions Directorate (WL/MN) at Eglin AFB, Florida. The CDMA spread spectrum approach is intended to allow DoD use of portions of the upper S-Band frequency spectrum (between 2310-2360 Mhz), recently redesignated for commercial use. (Note: DoD is still authorized to use this frequency band on a non-interference basis.) Therefore, an evaluation must be conducted to determine the maximum CDMA power levels which result in interference, as well as the definition of interference, with the digital automotive radio systems that operate in this frequency range. Finally, commercial manufacturing feasability must be assessed regarding the economical production of the SMT instrumentation, using CDMA spread spectrum technology.

PHASE I: Evaluate the feasibility of developing enhanced CDMA spread spectrum technology and integrating it into SMT instrumentation that would avoid commercial interference and could be produced with commercially available components.

PHASE II: Design, develop and produce a prototype CDMA SMT system capable of meeting Air Force test requirements, within production design cost goals

PHASE III DUAL USE APPLICATIONS: CDMA SMT has a wide range of potential commercial uses, including intelligent/automated highway vehicles, commercial aviation, shipping and trucking.

REFERENCES: "Subminiature Telemetry for Multiple Munition (Technology Transition)", J.M. Cullen and Ed Keller, paper presented at the 1995 International Telemetering Conference (ITC), 30 Oct- 2 Nov 95, Las Vegas, NV, Instrument Society of America, 1995, p.58-65.

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-273 TITLE: Multiple Direction Blast Pressure Measurement

CATEGORY: BASIC RESEARCH; Conventional Weapons

OBJECTIVE: Develop a capability to measure the true blast wave data.

DESCRIPTION: The munitions research, development, test and evaluation community has long needed the ability to accurately measure the blast pressure wave which is generated during a warhead explosion. Blast pressure wave data (pressure-time trace) are obtained during a number of different types of explosive event characterization tests by positioning pressure gages around the exploding warhead. However, pressure gages suffer from two basic problems: response time and direction. Since the explosive items which are tested are not generally spherical and center initiated, the precise wave shape is difficult to predict and therefore the current blast pressure measurement techniques make positioning of the blast pressure measurement gages a problem.

PHASE I: Define the hardware/software necessary to accomplish the task of determining the true blast pressure-time trace (even with some uncertainty of wave vector).

PHASE II: Design, develop and produce a prototype system and integrate the software. Validate the system during actual test events under benign test conditions and document the results.

PHASE III DUAL USE APPLICATIONS: Industries using explosive devices: oil and mining, road and building construction, safety and avalanche control (resort industry).

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded

small business.

AF98-274 TITLE: High-Level Electromagnetic Field Generation Capability

CATEGORY: Engineering Development; Conventional Weapons

OBJECTIVE: Develop enhanced radiated susceptibility techniques for application in an existing shielded anechoic chamber.

DESCRIPTION: The Air Force must test many electronic systems for susceptibility against a wide spectrum of radiated electromagnetic (EM) fields. Many methods currently exist for generating the required high-level EM fields within a controlled test environment. However, each method has its own specific strengths and weaknesses, usually related to radiation frequency and the size of test area. The following techniques are generally recognized as alternative methods for EM field generation within a test chamber: (1) reverberation, (2) T-line or coaxial (as described in MIL-STD-462, Notice 4), (3) mode stirred, (4) frequency stirred, (5) parallel plate T-line or strip line (as described in MIL-STD-462 for the RS04 Test Method), and (6) transverse electromagnetic mode cell. The need exists to explore the available EM radiation methods/techniques and to determine how the use of these methods (or combination of methods/techniques) can maximize the test capabilities within the existing anechoic test chamber located at Eglin AFB, Florida. Test capabilities are desired between the 14 KHz to 40 GHz frequency range for EM fields, and possibly the 30 Hz to 1 MHz range for magnetic fields.

PHASE I: Research and develop high-level field generation methods and techniques, and determine the feasibility and relative merits of each method's application in the existing Eglin AFB test chamber (avoiding any loss in current test capability). Define the specific use and implementation of the best methods (or mix of methods) to maximize the achievable utility of the susceptibility chamber. Document results and prepare validation test plans.

PHASE II: Design, develop, produce and implement the prototype equipment necessary to maximize the test capabilities within the chamber. Demonstrate and validate the system capabilities; document the results and the method of operation.

PHASE III DUAL USE APPLICATIONS: Commercial use includes multiple EM susceptibility testing applications for electronic systems. Examples are in the advanced automotive, medical equipment, computer and aviation fields.

REFERENCES: MIL-STD-461, MIL-STD-462

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-275 TITLE: Advanced PC-Based Telemetry Processing and Display System

CATEGORY: Engineering Development; Computing and Software

OBJECTIVE: Develop an advanced PC-based telemetry processing and display system to support the needs of Air Force flight testing.

DESCRIPTION: Recent advancements in commercial computer architecture have created an opportunity for significant break throughs in digital data acquisition, processing and display systems needed to support Air Force flight testing. The private sector has developed board-level telemetry input modules and object-oriented software processing engines for both the military and commercial test users. While these systems address the general data acquisition requirement, they do not support the full scope of flight test requirements. The technical challenge of this effort is to leverage the recent innovations in hardware and software and create a new advanced Personal Computer (PC)-based telemetry processing and display system, with low acquisition and life-cycle support costs. The system should possess a low cost, common, re-configurable system architecture that is fully responsive to the real-time telemetry processing needs of developmental and operational flight testing. It is anticipated that this effort will require development of a high end telemetry input module, capable of combining the traditional functions of a Pulse Code Modulator (PCM) bit synchronizer, PCM decommutator and Inter-Range Instrumentation Group (IRIG) time code translator, into a single Peripheral Computer Interface (PCI)-based form factor. This effort will also include integration with Windows New Technology (NT) telemetry processing display software.

PHASE I: Research appropriate technologies and determine hardware and software requirements for advanced PC-based telemetry processing and display system. Define system architecture, accomplish design trade-offs and prepare validation test plans.

PHASE II: Design, develop and produce a prototype system. Verify and validate system performance through functional and operational demonstrations; document results.

PHASE III DUAL USE APPLICATIONS: Multiple commercial uses including test support in the advanced automotive and aircraft industry; system also used in control and monitoring of industrial manufacturing processes.

REFERENCES: IRIG STANDARD 106-96, Telemetry Standards, RCC Range Commanders Council

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-277 TITLE: Weapon Lethality Assessment Instrumentation Technology

CATEGORY: EXPLORATORY DEVELOPMENT; Conventional Weapons

OBJECTIVE: Develop advanced instrumentation for lethality testing and Battle Damage Assessment.

DESCRIPTION: Traditional lethality test and evaluation (T&E) methods are labor intensive, subjective, and expensive. Methods are needed to generate more objective data to support model-based results. Similarly, current Battle Damage Assessment (BDA) techniques rely on visual imagery and are, accordingly, subjective in results. The visual method may be accurate for hit-to-kill weapons that produce clear catastrophic damage; however, many munitions produce damage modes not readily observed by visual methods. Detection, recording and processing of other real-time observable signature characteristics (i.e., acoustic, infrared, magnetic, etc.) emitted from the target before, during, and after warhead detonation may more accurately and objectively assess actual battle damage and lethality. Innovative concepts and instrumentation must be developed to accurately record weapon impact and damage event data for assessment of weapon effectiveness and operational battle damage. The technical challenge of this topic is to determine the most effective methods of remote sensing and real-time data fusion and processing. Promising methods of remote sensing include: imaging laser-radar, infrared spectroscopy, hyperspectral imaging, pyrometry, and pressure measurements. Various concepts would likely require unique instrumentation and recording devices. All instrumentation and devices should be integrated and adaptable to measure the effects of a wide variety of weapons, including bombs, submunitions, warheads, and projectiles. Significant innovation is anticipated in the application and mix of the required instrumentation and devices.

PHASE I: Develop innovative concepts, and downselect the concepts for best value. Research the feasibility of the selected concept. Define all hardware and software requirements.

PHASE II: Design, develop, and integrate a prototype ethality/ battle damage assessment instrumentation system. Verify and validate system performance through realistic testing and demonstration.

PHASE III DUAL USE APPLICATIONS: Police and FBI bomb squad use, particularly in assessing terrorist activities. Commercial use as instrumentation harsh environments such as blast furnaces and chemical reactors.

REFERENCES: Hyperspectral Imaging Field Test, DTIC Accession #DF527228, 22 Nov 96

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-278 TITLE: Tightly Coupled Global Positioning System (GPS)/Inertial Navigation Systems (INS) Laboratory Test Capability

CATEGORY: Engineering Development; Air Vehicles/Space Vehicles

OBJECTIVE: Develop the ability to test tightly coupled GPS/INS systems in a hardware-in-the-loop laboratory.

DESCRIPTION: The capability to perform test and evaluation of GPS receivers loosely coupled with INS has been demonstrated. Presently, dynamic laboratory tests of the GPS and inertial portions of navigation and guidance systems can only be performed separately by providing inertial inputs or simulated GPS satellite signals. Testing tightly integrated systems, such as the Embedded GPS/INS (EGI) system, is desired.

Given access to a robust RF GPS signal simulator, hardware-in-the-loop integration test beds, programmable rate tables and centrifuges, accomplish the following: (1) design an architecture which integrates some or all of this laboratory equipment and (2) identify tests which effectively use this architecture to test tightly coupled GPS/INS systems and navigation suites.

PHASE I: Investigate methods and design a system architecture to enable hardware-in-the-loop laboratory testing of a tightly coupled GPS/INS system. Perform a trade-off analysis of integrating motion devices to stimulate inertial hardware (i.e., rate tables and centrifuges) vs. modeling inertial systems in software.

PHASE II: Hardware and software development, procurement, installation, and checkout of the Phase I design.

PHASE III DUAL USE APPLICATIONS: The development of low cost techniques and methods to test GPS/INS integrated systems, by providing for laboratory tests accomplishing many of the goals of more expensive flight tests.

REFERENCES: An Infrastructure Architecture for the Testing of GPS Sensors Tightly Coupled with Other Sensor Systems, Proceedings of the 52nd Institute of Navigation, June 1996.

AF98-279 TITLE: Adaptive Antenna Array for Radar Cross Section (RCS) Measurements

CATEGORY: EXPLORATORY DEVELOPMENT; Electronic Warfare/Directed Energy Weapons

OBJECTIVE: Develop a method to improve the field taper incident on the target and reduce the backscatter from clutter.

DESCRIPTION: RCS measurements require a planar wave front over the target aperture. Currently, Radar Target Scatter Division (RATSCAT) uses a single parabolic dish antenna to form a wave front at each frequency. These antennas have proven reliable for many years but as targets become lower in RCS, the background clutter becomes a limiting factor in making accurate measurements. This topic explores using technology beyond a single parabolic dish to allow testing of the next generation in stealthy vehicles. For example, by using several antennas slightly out of phase with one another, an array could be utilized to focus more energy onto the target being tested and less on target supports. Other ideas include using an adaptive antenna array to detect the location of the greatest amount of undesirable backscatter, and automatically place a null in the main beam at this location. The array could reduce unwanted background clutter, while increasing the area of focused energy on the target.

PHASE I: Investigate recent developments in adaptive array technology and intelligent algorithms. Perform modeling and simulation of the proposed system. Report on the feasibility of implementing a system at RATSCAT.

PHASE II: Implement concepts by developing an intelligently controlled adaptive array. Implement intelligent algorithms, advances in machine intelligence and neural networks, or other methods to allow efficient testing. Perform RCS measurements at RATSCAT using the system and compare to theoretical results. Compare the results with measurements using the existing antenna systems. Report on actual performance of the system with respect to minimizing clutter and potential improvements in measurement capability.

PHASE III DUAL USE APPLICATIONS: The results of this SBIR would be an array of antennas which would be tuned using some sort of control system (A PC for example) which would be able to manipulate the antenna beam pattern for the array. This research could be transferred to the very large number of commercial antenna manufacturers, instrumentation radar manufacturers, remote sensing groups, telephone and communications companies, television companies, satellite users, and operators of indoor chambers used for a variety of electromagnetic applications including RCS measurements, antenna measurements, and electronic warfare related activities.

REFERENCES: Vertical Antenna Array Applications on a Ground-Bounce Instrumentation Radar Range, Captain Brian Fischer, 46 TG/TGR, RATSCAT Division, Holloman AFB, NM 88330.

AF98-280 TITLE: Reduced Radar Cross Section (RCS) Modification to T-38 Aircraft

CATEGORY: Engineering Development; Materials

OBJECTIVE: Develop a method to reduce RCS of T-38 aircraft for use as low RCS target for radar testing.

DESCRIPTION: The T-38 aircraft is used extensively throughout the military research and development community as a target aircraft during radar system development. The government desires a modification be made to reduce the radar cross section of the T-38. The modification should be designed to maintain safety of flight, minimize costs and minimize increased maintenance. The flight envelope of the aircraft should be impacted as little as possible due to the modification, although external appearance of the aircraft may be modified. The T-38 aircraft has a basic operational envelope of +7.33 g's to -3.0 g's, airspeed limit of 710 KIAS, and altitude limit of 50,000' MSL. These limits should not be significantly reduced due to the application of materials or modification of the aircraft, with the exception of airspeed, which can be reduced to 600 KIAS. The aircraft, once modified, would not be required to fly at night, in precipitation or icing.

PHASE I: Conduct engineering studies to provide cost-benefit tradeoffs for RCS reduction versus frequency, aspect angle, maintenance impact, aircraft performance and overall cost. Recommend the preferred treatment method and provide detailed RCS analyses and tests to substantiate that projected RCS values are attainable. Conduct preliminary design efforts to incorporate modifications into T-38 aircraft.

PHASE II: Design, produce and install Class II modification components to achieve RCS reduction on two T-38 aircraft. Participate in the flight test program to test RCS performance of the T-38 aircraft and document program results.

PHASE III DUAL USE APPLICATIONS: The results of this SBIR could be applied by small businesses to develop an entire fleet of reduced RCS targets useable by the DoD for research and development tests of other systems.

AF98-281 TITLE: Bandwidth Efficient Telemetry Access (BETA)

CATEGORY: Advanced Development; Command, Control, and Communications (C3)

OBJECTIVE: Develop advanced communications end-equipment to provide cost efficient switching of wideband telemetry data using commercial communications standards.

DESCRIPTION: Existing Telemetry (TM) data distribution technologies have not kept pace with the weapon system requirements. Telemetry data is normally manually routed point-to-point using patch panels which lack flexibility and the ability to provide bandwidth on demand. At the same time, TM data-stream bandwidth requirements are projected to increase significantly in the next decade. For example, the F-22 program has a hard requirement for ground-based switching of two 5 Mbps data streams, the B-2 requires 2.4 Mbps, the Joint Strike Fighter will require 10-12 Mbps, and the Airborne Laser lab will require data distribution of up to 80 Mbps. Mission support requires real-time intra-range data transfer (encrypted and clear text) from the receiver sites to approximately 10 customer facilities on base, or real-time inter-range data transfer to one or more military bases. Inter-range communications of 1.5-10 Mbps TM data can be accomplished today using expensive end equipment and DS-3 commercial service. Other bandwidth and cost efficient methods of transmitting data warrant investigation under this SBIR including Asynchronous Transfer Mode (ATM) technology and inverse multiplexing. The task at hand is to provide advanced development of communications switching end-equipment to achieve cost and bandwidth efficiency. The equipment needs to interface with TM standards (Inter-Range Instrumentation Group (IRIG) 106-96) to commercial telecommunication standards via dedicated range lines or via the public network. It must also accommodate a wide range of telemetry bandwidths (128 kbps and up), be flexible in providing either broadcast or point-to-point connections, and be cost efficient. Issues to consider in the proposal include latency, delay variations, frequency stability, and synchronization.

PHASE I: Conduct a feasibility analysis and propose a recommended system design. Technical and cost trade-off analyses are desired.

PHASE II: Construct a prototype system and demonstrate it at the AFFTC, Edwards AFB, California. The demonstration system will be evaluated to determine how well it satisfies the AFFTC requirements. The operational suitability of future deployable Phase III systems will be inferred from the Phase II results.

PHASE III DUAL USE APPLICATIONS: This solution may be in the development path of, and provide risk reduction to, the Advanced Range Telemetry (ARTM) development project. Many other applications to commercial and defense related fields are envisioned, including (1) enhancements to existing communication systems across multi-service installations, (2) data interfaces, (3) inverse multiplexers, (4) ATM switches, etc. Also, expected beneficiaries of this technology, in addition to ARTM, include the

Joint Regional Range Complex development project, F-22, F/A-18 E/F, JSF, ABL, B-1B, and B-2A programs.

REFERENCES: IRIG 106-96, "Telemetry Standards," May 1996.

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-282 TITLE: Range Atmospheric Visibility Monitoring (RAVM)

CATEGORY: Advanced Development; Electrotechnology and Fluidics

OBJECTIVE: Develop an advanced capability to monitor atmospheric visibility throughout an open-air range and measure its degradation effects on range sensors operating in the visible and near infrared regions of the spectrum.

DESCRIPTION: The ability to continuously capture and disseminate timely information on current atmospheric visibility is important to the efficient conduct of test operations at all open-air ranges which use optical tracking. In this context, the term visibility relates to the ability of imaging sensors to "see" objects at long ranges. Advanced knowledge of current visibility conditions across a broad frequency spectrum could be very useful in improving (or maintaining) the robustness of the test-data collection process. The ability to capture high-quality, high-resolution, performance data using film-based cinetheodolites and electro-optical sensors is often difficult to achieve because of degraded visibility at sensor and emitter operating wavelengths (400nm-12um). The quality of data collected during a test is often unknown until processing is performed after the event. If the data is unusable, the test may have to be rerun. Because of high costs associated with live testing, attempts have been made to predict visibility using the human eye. But, this method has proven to be operationally unsuitable due to optical differences between the human eye and the sensor optics as well as being highly subjective in nature. Several factors can effect visibility. Optical turbulence caused by surface heating is a major source of degradation. Sun angle, clouds, wind, haze, airborne particulate, and fog can contribute to poor visibility. Other factors also affecting visibility are the apparent size and features of the target, and the mission profile. Visibility is also affected by location, optics, and look angles of sensors. Weather conditions, which might vary depending on the sensor location, also affect visibility. The goal of the Air Force Flight Test Center (AFFTC) is to develop an affordable atmospheric visibility measurement capability to support range scheduling and test operations. This capability will predict the maximum resolution of targets ranging from small fighters and drones to large transport aircraft. Optical assets should be able to image targets within ten percent of predicted maximum range. The visibility information should be current and it should be presented in a form that highlights key situations and is easily understandable by range operations personnel.

PHASE I: Conduct a feasibility analysis and prepare a recommended system design.

PHASE II: Develop and demonstrate a prototype system at the AFFTC, Edwards AFB, California. The demonstration system will be evaluated to determine how well it satisfies the AFFTC requirements. The operational suitability of future field deployable PHASE III systems will be inferred from the PHASE II results.

PHASE III DUAL USE APPLICATIONS: Numerous applications to commercial and non-defense related fields are envisioned, including enhancement to existing weather information systems, environmental emissions detection, tracking, and management, airspace utilization and management, and resource location and mapping.

REFERENCES:
1. NWC TP6869, "Visibility Conditions and Causes of Visibility Degradation in the Mojave Desert of California," RESOLVE Project Final Report, July 1988.
Study performed in the1980's to track atmospheric conditions at China Lake, Edwards, Fort Irwin, and George AFB over a time span of several years to identify sources of degradation and to quantify declining resolution of electro-optical sensors due to environmental changes. Executive Summary ADA 206-322 Final Report, ADA 206-321.
2. SAIC Document # A0011-023-01, "EAFB Analysis of Air Visibility Impacts to Test Operations," August 1990.

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-283 TITLE: Modular Affordable Global Position System/Inertial Navigation System (MAGI)

CATEGORY: Advanced Development; Sensors

OBJECTIVE: Develop a system to advance the technology of Global Position System (GPS) Time Space Position Information (TSPI) Range Instrumentation System (RIS).

DESCRIPTION: A robust, flexible, reliable, modular, low cost TSPI system capable of operating in a low-to-high dynamic flight environment is required to support test and training missions of modern aircraft. The system must mount in internal equipment bays of fighter, trainer, and cargo size military aircraft. The system, conceptually, should be Plug-and-Play modular hardware and software, in order, to be quickly reconfigured between airframes by mid level technicians and with a minimal setup time. The modular concept should allow for control of interfaces, but not of subsystem assemblies, i.e., GPS receiver, inertial reference unit, etc. The system should meet or exceed today's current GPS and inertial navigation system (INS) capabilities; for example, all in view capability, Wide Area GPS Enhancement (WAGE), and L1, L2 and new L5 (if applicable) carrier tracking, and direct Y-code acquisition. The production goals are a maximum volume of 100 cubic inches, power consumption less than 30 watts, and a cost less than $10K per unit. It should use a small, conformal, surface mounted GPS antenna. It should be capable of all-in-view multichannel tracking with a tightly coupled INS. The INS goals are maximum volume of 15 cubic inches and a cost less than $2000 per unit. In addition, the INS should be highly reliable with a gyroscope drift rate performance of less than one degree per hour and an accelerometer bias stability of less than 300 micro-g's. The data from these units should be available on an RS232/422 port and consist of raw GPS data at 1 Hz and raw INS data at 256 Hz as well as the blended solution.

PHASE I: Conduct a feasibility analysis and prepare a recommended system design for several conceptual options. Submit a final report covering the analytical results and system design.

PHASE II: Build and demonstrate a proof-of-concept system to AFFTC. Submit a final report on demonstration results.

PHASE III DUAL USE APPLICATIONS: Commercial and private aviation could benefit from having a low-cost GPS TSPI system. Benefits could range from en route analysis for airline efficiencies and use with airline black box recorders for Federal Aviation Administration (FAA) incident and accident investigations. Additional use could be for development of commercial aviation safety-of-flight simulations and actual en route mission training databases for use in commercial simulator pilot training (initial and proficiency).

REFERENCES: "Navigation" The Journal of the Institute of Navigation has several articles discussing new GPS receiver technology incorporating WAGE and addressing miniaturized, low cost GPS and INS systems. Two articles in the Fall 1996, Volume 43, Number 3 issue consist of: "Options for PPS Space Segment Accuracy Enhancement," by Mark L. Moeglein, David H. Nakayama, and Cheryl L. Hammer, p.221-235 and "Tightly Coupled IFOG-Based GPS Guidance Package," by Neal J. Dahlen, Thomas L. Caylor, and Eric L. Goldner, p.257-271.

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AF98-284 TITLE: High Performance Digital Modulation for Air-to-Ground Telemetry

CATEGORY: EXPLORATORY DEVELOPMENT; Command, Control, and Communications (C3)

OBJECTIVE: Develop high performance digital modulation technique for higher bit rates, improve spectrum use efficiency and maintain or increase link reliability in air-to-ground telemetry.

DESCRIPTION: Department of Defense (DoD) aeronautical and missile test ranges are under pressure to increase the throughput of test vehicle air-to-ground data links. At the same time, the amount of radio frequency (RF) spectrum available for these applications is decreasing [1]. The majority of digital data links at DoD ranges utilize pulse code modulation/frequency modulation (PCM/FM) (Continuous Phase Frequency Shift Keying, CPFSK) with a modulation index of 0.7 to deliver bit rates up to about 5 Megabits per second in the L and S bands with spectrum occupancy rates of about 1 bit/second/Hertz (in terms of National Telecommunication and Information Administration (NTIA) spectrum mask). Flight vehicle telemetry at DoD ranges is challenging because of Doppler shift, multipath, fading, operating distance, "near/far" and inter-range interference problems. It is already known that other modulation methods exist that can potentially double bit rates, or better [2]. However, the advanced methods have not been

tried in aeronautical test applications beyond computer simulations. The intent of this SBIR topic is to develop an improved telemetry link throughput in a given bandwidth while delivering otherwise equal or better performance than the baseline. Modulation methods must be compatible with DoD aeronautical test applications. The performance characteristics of PCM/FM, h=0.7 will be used as a performance baseline (in all respects). Field demonstrations, of the modulation technique(s), will be demonstrated in real flight situations.

PHASE I: Research modulation methods in terms of technical performance characteristics and implementation cost impact. Select and propose one or more specific methods for demonstration.

PHASE II: Build and test a demonstration system. Validate performance and characteristics in laboratory or ground based open-air-tests and support flight trials at the Air Force Flight Test Center, Edwards Air Force Base, California.

PHASE III DUAL USE APPLICATIONS: High performance modulation methods are actively being researched in the commercial sector. New "wireless" data services are emerging for corporate and personal environments and there is a great deal of money to be made from these new opportunities. A company that can develop and successfully market a truly beneficial new or improved modulation scheme before the markets are closed by standardization efforts can do well. Even if not successful in the wireless competition, there is potential for new modulation methods in wireline modem and short-range instrumentation system markets.

REFERENCES:

[1] Timothy A. Chalfant, Erwin H. Straehley and Earl R. Switzer, "Advanced Range Telemetry (ARTM) Preparing for a New Generation of Telemetry," Proceedings of the International Telemetering Conference (ITC), Vol. XXXII, 1996, paper number 96-24-2.

[2] Sharmin Ara and William P. Osborne, New Mexico State University, "Review of Bandwidth Efficient Modulation Schemes," Proceedings of the ITC, Vol. XXXI, 1995, paper number 95-02-1.

[3] Telemetry Standards, IRIG Standard 106-96, May 1996, Secretariat, Range Commanders Council, U.S. Army White Sands Missile Range, New Mexico 88002-5110.

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-285 TITLE: Common Terrain Database and Real Time Terrain Database Server

CATEGORY: EXPLORATORY DEVELOPMENT; Computing and Software

OBJECTIVE: Develop a terrain database for simultaneous infrared, radar and Communication Navigation Identification (CNI) simulations, suitable for integrated avionics installed system tests.

DESCRIPTION: Integrated avionics testing of advanced aircraft in Anechoic chambers requires the use of multiple simulators/stimulators to the System Under Test (SUT). Technologies are needed to develop a common terrain database to ensure a high degree of correlation between events simulated in the infrared (IR), radar, and CNI frequency spectrums. Target placed spatially and temporally should be spatially and temporally correlated in all the IR, radar, and CNI spectral bands. The IR bands shall be a minimum of 3.0 to 12.0 microns. The radar spectral bands shall cover 100 MHz and up. The CNI spectral bands are similar to the radar. The database shall be expandable to cover the ultraviolet (UV) and visual spectrum. Significant innovation is required to solve the problem of real-time database access which will not impede the generation of multi-spectral scenes. The terrain database will account for all naturally including backgrounds, cultural features, sky, targets (air, land, or sea) (stationary or mobile), atmosphere, obscurants, and clouds.

PHASE I: Conduct a feasibility analysis, determine fidelity requirements/performance, recommend a top-level architecture and functional block diagrams for both the terrain database generator and terrain server concepts. Conduct optional tests and demonstrations as appropriate and within Phase I budget. Submit a final report covering the analysis results, fidelity requirements, the system design and optional activities.

PHASE II: Develop a proof of concept system and demonstrate its operation to the Air Force Flight Test Center (AFFTC). Submit a final report on the development and test results.

PHASE III DUAL USE APPLICATIONS: IR/visual/radio frequency(RF) scene simulation software is proliferating, fueling a need for multi-spectral terrain databases to satisfy military and commercial uses. A robust terrain database generator and terrain database server will find widespread acceptance for the simulation of IR, visual, UV, and RF scenes or for scene simulation severs. As such, there is potentially widespread acceptance and use of the databases and servers.

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-286 TITLE: Radio Frequency (RF) Plane Wave Generator

CATEGORY: Advanced Development; Sensors

OBJECTIVE: Develop a cost-effective capability for generating free space RF plane waves within very large anechoic chambers.

DESCRIPTION: The need is to generate simulated planar RF waves to test installed integrated avionics systems in a cost-effective manner. The capability shall generate a high quality RF plane wave which is at least equivalent to four far field standard distances. This system should be capable of receiving and transmitting the planar wave. The plane wave quiet zone should be at least 50 feet wide and 25 feet high. The plane waves generated must be dynamically steerable and will include multiple simultaneous and time shared signals with polarization agility for stimulating the apertures of medium sized aircraft in a realistic fashion as determined by a test scenario. Beam steering will be within a 12-degree cone. Estimated overall performance requirements are as follows: Frequency band will be 0.5GHz to 18GHz with a polarization agility capability, and RF input power will be 100 watts or greater. Additionally, the capability must: present a low radar cross section, be mobile for placement within the anechoic chamber, and be designed for easy removal from the anechoic chamber.

The RF plane wave generator should be compatible with radar target, communication navigation identification (CNI), and electronic warfare threat signals. The plane wave generator design must be extensible and synergistically compatible, to allow multiple plane wave generators to be used together.

PHASE I: Research the technical and economic feasibility and propose a system.

PHASE II: Build a system and demonstrate in the Benefield Anechoic Chamber at Edwards AFB, California.

PHASE III DUAL USE APPLICATIONS: All anechoic chambers which test antenna systems require systems to generate planner RF waves. This technology will be a cost-effective approach to produce these high fidelity RF signals which are required for aircraft, satellite, and ground systems antenna testing in commercial and government anechoic chambers. The new technology of dynamically steerable signals will increase the ability of the chambers to test larger and more capable systems.

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-287 TITLE: Characterization of Ozone Transport into Eastern Kern County

CATEGORY: Advanced Development; Environmental Quality/Civil Engineering

OBJECTIVE: Develop new technology to characterize Ozone transport into eastern Kern County on a real-time basis.

DESCRIPTION: Eastern Kern County, where the bulk of Edwards AFB is located, is currently classified as serious non-attainment for ozone by the US Environmental Protection Agency. This classification results in significant regulatory impacts and related costs to the base's operations. However, current data indicates that ozone levels in eastern Kern County rarely exceed National Ambient Air Quality Standards (NAAQS) for ozone. Rather, the current data suggests that during actual exceedances of NAAQS, ozone is in fact transported from the San Joaquin Valley (western Kern County) into eastern Kern County. Current techniques of seeding air to measure transport effects does not produce day-to-day dynamic real-time measurement of inter-zone ozone transport which is required to document the transport extent. The requirement of this effort will be: 1) development of a real-time ozone transport measurement system which will characterize ozone inter-state transport in eastern Kern county. The final product should be an operating ozone transport measurement system and detailed report that verifies it's operation and characterizes transport of ozone into eastern Kern County.

PHASE I: Determine the feasibility to measure in real-time the dynamic Ozone intra-state transport which can characterize the transport from the San Joaquin Valley into eastern Kern County.

PHASE II: Develop a real-time dynamic Ozone inter-state transport measurement system and verify operation by characterizing the east Kern County ozone transport, including graphical representations of transport effects.

PHASE III DUAL USE APPLICATIONS: Technologies and techniques that are developed to conduct this work can be applied by other Federal Facilities, and non-federal agencies (such as local air districts), that are in similar non-attainment situations that are the result of intra-state transport of pollutants.

REFERENCES: Characterization of Ozone Transport into Mojave Desert Using Halocarbon Tracers of Opportunity, Keislar, R. E., and Schorran, D. E., 1996 89th Annual Meeting & Exhibition, Air & Waste Management Association, 1-16.

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-288 TITLE: Pressure-Sensitive Paint for Broad Spectrum of Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop new pressure-sensitive paints for aerodynamic testing.

DESCRIPTION: Much interest has developed in the use of luminescent paints for measuring distributions of surface pressures in aerodynamic testing. Measurements are typically based on oxygen-quenching of fluorescent dyes. These are excited by short-wavelength, visible light, and emit at longer wavelengths, but still in the visible part of the spectrum. The dependence of the emission yield on oxygen quenching may be exploited to measure pressures or temperatures at the surface, or both.

As the technology matures, the list of desirable paint properties continues to grow. Mechanical requirements include: durability, creep resistance, uniformity, smoothness, removability, short drying time, and high-temperature hardness. Optical requirements include: well-separated excitation and emission bands, high emission yield, pressure-sensitivity in the absence of temperature-sensitivity, low photo-degradation, and diffuse reflectivity. Depending on the application, other special requirements might include electrical conductivity, microsecond response time, high-pressure dynamic range, high emissivity in the infra-red, and low toxicity.

Proposals are solicited for pressure-sensitive paints that combine as many of the above properties as possible. Initial target pressure and temperature ranges are 200 to 2000 psf and 20 to 150 deg F in air. Proposals for both single- and multi-luminophor paints will be considered, e.g., having emission bands that give a pressure-signal, a temperature-correction signal, and a reference signal, against which the other signals are ratioed to compensate for non-uniform illumination. Optimized filters must be specified for the illumination and detection systems.

PHASE I: A proof-of-principle demonstration, including a pressure-measurement accuracy of 1% in the presence of 20 deg F temperature variations will be performed.

PHASE II: Tailor the product for specific needs of the sponsoring agency and improve the pressure measurement accuracy to 0.2%.

PHASE III DUAL USE APPLICATIONS: Automotive Research & Development, oxygen sensors, biomedical applications, glow-in-the-dark toys.

REFERENCES:
1. B. G. McLachlan and J. H. Bell, "Pressure-sensitive paint in aerodynamic testing," Experimental Thermal and Fluid Science, Vol. 10, pp. 470-485 (1995).
2. A. E. Baron et al., "Submillisecond response times of oxygen-quenched luminescent coatings," Review of Scientific Instruments, Vol. 64, No. 12, pp. 3394-3402 (1993).
3. M. J. Morris et al., "Aerodynamic applications of pressure-sensitive paint," AIAA Journal, Vol. 31, No. 3, pp. 419-425 (1993).

NOTICE: Only government personnel will evaluate proposals. However, base support contractors may be used to monitor contract performance and testing. Any contract award may require a nondisclosure agreement between base support contractors and awarded small business.

AF98-289 TITLE: Active Pixel Sensor Camera for Scientific Imaging

CATEGORY: EXPLORATORY DEVELOPMENT; Sensors

OBJECTIVE: Develop a high quality, digital imaging camera with randomly addressable pixels for luminescent imaging.

DESCRIPTION: Active-pixel sensor cameras that can rapidly acquire high quality images are needed to provide flexibility for image-based data acquisition systems typically used in Pressure Sensitive Paint (PSP) applications. Electronic panning and on-camera windowing are required to interrogate specific regions of the pixel array without the need to process the entire array. Monochrome and multicolor cameras are needed. The cameras must have low power requirements and should be small enough to permit them to be used as probes (as opposed to optical fiber probes) that provide optical access to complicated shapes.

Minimum requirements for both monochrome and multicolor cameras are: 75 dB dynamic range, 12 bit A/D conversion, 2.5 Mpix/sec readout speed, 60% quantum efficiency, 0.01% nonlinearity, 500 pA/cm2 dark current at room temperature, 1% gain uniformity, and 3 mW power dissipation at 100Kpix/sec. Multicolor cameras should be able to image at least three different optically separated colors in the visible and near infrared spectrum.

Advanced PSP applications require a multicolor camera to make nearly simultaneous measurement of complementary pressure, temperature, and reference images for greatly improved data quality. Every fifth pixel could be read for coarse monitoring while reading every pixel for detailed images. Specific PSP applications, in wind tunnel testing, may require the reading of pixels of a region of interest on a model ten times and averaging on the camera while reading the pixels of adjacent areas once.

PHASE I: Develop and demonstrate a monochrome active-pixel camera that records high quality images with at least a 512x512 pixel array, has at least a 12 bit digital readout, and operates at 10 Hz or better for the full array

PHASE II: Produce and deliver to Arnold Engineering Development Center, TN a marketable-prototype active-pixel camera with an array size of at least 1024x1024, a demonstrated imaging speed of 10 Hz or better, digital resolution to 16 bits, effective fill factor of 75% using micro-optics, and demonstrated multicolor capability.

PHASE III DUAL USE APPLICATIONS: The commercial market for an active pixel camera is substantial. The basic technology is applicable to infant monitors, home security, and enhanced automotive field of view devices. The scientific grade imaging is applicable to machine vision, hazardous environment inspection equipment, low light-level imaging, and movie industry applications. The inherent low power requirements and small size also make it applicable to personal imaging systems and biomedical endoscopy.

REFERENCES:

1. *M. J. Morris et al., "Aerodynamic applications of pressure-sensitive paint," AIAA Journal, Vol. 31, No. 3, pp. 419-425 (1993).

2. *NASA Jet Propulsion Lab World Wide Web URL - http://137.79.14.14/APS_Page

3. *E.R. Fossum, Active Pixel Sensors -- Are CCDs Dinosaurs?, in CCD's and Optical Sensors III, Proc. SPIE vol. 1900, pp. 2-14, (1993). sensors for low power, highly miniaturized imaging systems, Photonics Spectra, pp. 125-126, January 1996.

4. *Panicacci, S. Kemeny, B. Pain, and E. R. Fossum, Programmable multiresolution CMOS active pixel sensor, in Solid State Sensor Arrays and CCD Cameras, Proc. SPIE vol. 2654, pp. 72-81, San Jose, CA February 1996.

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AF98-290 TITLE: Model Attitude and Deformation Measurement System

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop a system that can accurately monitor the steady-state and dynamic position and deformation of a model in a large wind tunnel.

DESCRIPTION: Accurate measurement of the drag coefficient on a wind tunnel model is dependent on the precision of model attitude measurements. It has been estimated that an uncertainty of 0.01 degree will result in an uncertainty of 0.0001 (1 drag count) in drag coefficient. Also, the twisting and bending of the model can have a significant effect on test results when compared with flight test measurements. A system that can accurately measure the attitude and deformation of a wind tunnel model under air loads is

essential in estimating the performance of the full scale vehicle.

The system that is developed, for a large wind tunnel that performs development testing, must be easy to use and have no adverse effect on productivity or flow quality. The system should be capable of measuring model attitude (roll, pitch and yaw), where the model is at least 8 ft from the wall in a large wind tunnel, with a steady-state uncertainty of less than 0.01 degree and a dynamic range of approximately 100Hz. The system should also be capable of measuring both steady-state and dynamic model surface deflection with an uncertainty less than 0.001-in.

Techniques that measure model support position and estimate deflections of the support system from model loads require extensive calibration, do not account for deflections of the model, have too slow of a response to measure dynamic changes, and do not meet the accuracy requirements that are anticipated in the future. On-board inclinometers are more accurate but still do not address the model deformation issue. Optical systems that measure steady-state model position and deflection, using photogrammetric techniques that require one or more Charged Coupled Device (CCD) cameras, are too slow to measure dynamic changes.

PHASE I: Analytically and experimentally investigate the feasibility of developing a system that can measure both the steady-state and dynamic attitude and deformation of a wind tunnel model.

PHASE II: Produce and deliver to Arnold Engineering Development Center, TN a marketable steady-state and dynamic attitude and deformation measurement system for a large, production wind tunnel.

PHASE III DUAL USE APPLICATIONS: The most obvious market is the wind tunnel testing business; however, an optical measurement system with the capability to measure steady-state and dynamic deformation could be adapted to measure the deformation of larger structures such as buildings and bridges. The device could also be adapted for use in the precision measurement of 3-dimensional objects traveling along high speed production lines and in the automated fit-up of subassemblies on manufacturing assembly lines.

REFERENCES:
1. Burner, A.W. and Martinson, S.D. "Automated Wing Twist and Bending Measurements Under Aerodynamic Loads." AIAA 96-2253, June 1996.
2. Watzlavick, R.L., Crowder, J.P., and Wright, F.L. "Comparison of Model Attitude Systems: Active Target Photogrammetry, Precision Accelerometer, and Laser Interferometer." AIAA 96-2252, June 1996.

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AF98-291 TITLE: Accurate, Non-Intrusive, Global or Profile Measurement Device for One or More Flowing-Gas Properties

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop a device to measure the vector velocity, and/or temperature, and/or density in flowing air and/or exhaust gases.

DESCRIPTION: In testing turbine and rocket engines there is need to measure the above parameters accurately (less than 1 percent uncertainty) and non-intrusively (nothing protrudes into the flow) at flow positions which cover an entire cross section of the flow or, for small-scale (about 1 in. dia.) reacting rocket exhausts, to measure vector velocity over entire cross sections larger than the exhaust diameter for several exhaust diameters downstream. Beyond what is already present in the flow, there must be nothing added to the flows to make the measurement. Windows to be used in round ducts, the major emphasis, and in flat-walled tunnels must conform to the interior surface of the duct/tunnel. More compact devices than that possible with excimer lasers are envisioned. Tunnel and duct airflows of most interest (which are usually very dry) have cross-sectional dimensions ranging from 4 inches to 12 and 16 feet; 3 foot diameter ducts are very common. Airflow ducts are centered in test cells and held at test-altitude conditions; these cells are commonly 3 to 4 times the diameter of the duct. Turbine-engine exhausts are about the size of the airflow duct and open to the test-cell interior. Rocket exhausts of interest may range from 1 inch in diameter to several feet and are generally contained in test cells of much larger diameter. High acoustic and vibration levels are encountered. Typical test-cell/tunnel conditions are found in the first reference.

Respondents must cite the range of flow conditions, the time resolution, the spatial resolution, the measurement uncertainty and the measurement rate to be expected and the phenomena limiting these. The means of measurement over the flow cross section must be clear. Techniques of velocity measurement by Doppler effect should note the low uncertainty required to be

achieved.

PHASE I: Analytically and experimentally investigate the potentially show-stopping aspects of the device.
PHASE II: Produce and test a marketable prototype device.

PHASE III DUAL USE APPLICATIONS: These techniques will have application in any and all turbine-engine and rocket-engine testing facilities in the aerospace industry. Any industrial-process airflows and flame flows where accurate, non-disturbing distribution of the flow parameters is required will benefit from these products.

REFERENCES: Any issue of "AEDC Test Highlights" (Public Affairs Office; 100 Kindel Dr., Suite B212; Arnold AFB, TN 37389-2217), inside back cover.

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AF98-292 TITLE: Atomic Oxygen (AO) Beam Generator

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop a source of atomic oxygen atoms that mimics the atmospheric flux upon spacecraft.

DESCRIPTION: A complete simulation of space environments in ground based chambers requires a mechanism to explore the chemical effects of atmospheric atomic oxygen on rocket exhaust plumes as well as spacecraft surfaces. Presently, there exists a need for a device capable of providing a beam of atomic oxygen that has a flux similar to that experienced by an object at orbital speeds in the atmosphere at 300 km, or roughly 1015 atoms/(sec-cm2). A collimated source of atomic oxygen atoms that mimics the atmospheric flux upon spacecraft and that can generate a repeatable, substantial fraction of atoms in the neutral ground electronic state is required. This beam will be used to perform studies of rocket exhaust plume induced chemistry, using subscale rockets, in low to moderately-low flow vacuum chambers. The desired apparatus should provide:

1) a beam flux on the order of 1015 atoms/(sec-cm2)
2) an ultraviolet-free,ground state o-atom beam with less than 0.1% combined 0+, 02 and 0(1D) impurity
3) a narrow velocity distribution of the O atoms, centered near the 5-eV range
4) a cross sectional beam area on the order of 1 cm2

Furthermore, the device must be reasonable in size (i.e. approximately 0.5 m x 0.5m x 0.5m), simple to operate, and extremely reliable.

PHASE I: A concept demonstration and evaluation of the proposed AO beam generator will be performed.
PHASE II: Develop a design for a manufacturing facility suitable for short production runs of MCT arrays. Produce a number of sample MCT arrays to prescribed Air Force specifications.

PHASE III DUAL USE APPLICATIONS: The commercial market for such a device is extensive. This device will have use as a key element for spacecraft materials testing. The potential exists for the device to be used in high volume surface processing of silicon wafers or other computer-related hardware. Other uses would be in chemical diagnostic processing and surface analytic chemistry.

REFERENCES:
1. Moser, H.O. and Schempp, A., "Options for Generating Greater than 5-eV Atmospheric Species," in Rarefied Gas Dynamics: Space Related Studies, edited by E.P. Muntz, D.P. Weaver, and D.H.Campbell, Progress in Astronautics and Aeronautics, vol 116, 1988.
2. Caledonia, G.E., Krech, R.H., and Oakes, D.B., "Laboratory Simulation of Low Earth Orbit (LEO) Atomic Oxygen Effects," Journal of the Institute of Environmental Sciences, p23, March/April 1996.

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AF98-293 TITLE: Skin-Friction Measuring System for Large Wind Tunnels

CATEGORY: EXPLORATORY DEVELOPMENT; Air Vehicles/Space Vehicles

OBJECTIVE: Develop a system that can accurately measure the skin-friction distribution on models in a large, production wind tunnel.

DESCRIPTION: A high productivity, low cost technique for measuring the distribution of pressure and shear-stress is required to expedite the development of future flight vehicles by identifying areas with high drag early in the test program and to validate Computational Fluid Dynamics (CFD) codes that will be used to predict vehicle performance. The system to be developed must be robust enough to be operated in a large production wind tunnel and should require a minimal amount of time to prepare the model for testing.

The contribution of skin-friction to the total drag of a wind tunnel model is usually estimated from measurements of the total drag and the integrated pressure drag. The distribution of the skin-friction force cannot be determined from such measurements, but must be determined by measurements of the local shear-stress on the model. The measurement of the shear-stress distribution is important in evaluating the contribution of the individual components to the total skin-friction drag of a complex wind tunnel model. Accurate measurement of both pressure and skin-friction drag of the complete model is important for extrapolating model results to full-scale; the accurate measurement of the distribution is important in configuration development and CFD code validation.

A new technology, microelectromachanical systems (MEMS), could potentially be applied to measure both pressure and shear-stress distribution. A MEMS system that has sensors which are mechanical only and are interrogated non-intrusively is highly desirable since it will afford rapid, low cost installation on the test article.

PHASE I: Analytically and experimentally investigate the feasibility of developing a system that can measure the distribution of skin friction on a wind tunnel model.

PHASE II: Produce and deliver to Arnold Engineering Development Center, TN a marketable system that is capable of measuring the distribution of skin friction on a model in a large production wind tunnel.

PHASE III DUAL USE APPLICATIONS: In addition to companies involved in developing and refining aircraft performance, the technique can be applied to the development of low drag automobiles, and any other industry that requires monitoring and/or improving the efficiency of fluid flow systems.

REFERENCES:
1. Rubesin, M.W., Okuno, A.F., Mateer, G.G., and Brosh, A. "Flush-Mounted Hot-Wire Gage for Skin Friction and Separation Detection Measurements." 6th International Congress on Instrumentation in Aerospace Simulation Facilities, Ottawa, September 1975.
2. Morris, M.J., et al. "Aerodynamic Applications of Pressure-Sensitive Paint." AIAA Paper 92-0264, 30th Aerospace Sciences Meeting, Reno, NV, January 1993.
3. Reda, D., et al. "Areal Measurements of Surface Shear Stress Vector Distributions Using Liquid Crystal Coatings." AIAA Paper 96-0420, 34th Aerospace Sciences Meeting & Exhibit, Reno, NV, January 1996.
4. Mehregany, M., DeAnna, R.G., and Reshotko, E. "Microelectomechanical Systems for Aerodynamics Applications." AIAA Paper 96-0421, 34th Aerospace Sciences Meeting & Exhibit, Reno, NV, January 1996.

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AF98-294 TITLE: Low Cost Conformal Window Optics for Wind Tunnel and Test Cell Optical Diagnostics Applications

CATEGORY: EXPLORATORY DEVELOPMENT; Aerospace Propulsion and Power

OBJECTIVE: Develop a generalized approach for analysis and fabrication of low cost conformal optical elements for test cell and wind tunnel applications.

DESCRIPTION: Optical diagnostic techniques in wind tunnel and engine test cell applications require access to the flow regime of interest. Conventional window mounts introduce either cavities or optical flats, both of which produce undesirable effects in the boundary layer. Curved optics, in general, are not only costly but, more importantly, introduce optical aberrations. A complete

approach to the development of low cost conformal optical elements is required. For fixed optical systems, many aberrations can be overcome through the introduction of a compensating optical element (e.g., a cylindrical window can be compensated to first order by an orthogonal cylindrical lens). Typical optical diagnostic techniques include: interferometric flow field imagery, particle sizing, Raman spectroscopy, emission, and absorption spectroscopy, laser induced fluorescence, laser velocimetry, and beam scanning systems.

The optical elements must (not necessarily simultaneously): 1) impart limited disturbance to the duct flow 2) be capable of withstanding a differential pressure of less than +- 10 atmospheres, 3) be generally applicable over the UV- IR region, and 4) function over a temperature range of -80 to 750 oF. The duct/test cell walls may be cylindrical or of compound curvature.

A total system is required to analyze, and propose an optical configuration, assess the residual errors, and to produce the low cost corrector elements.

PHASE I: A demonstration and evaluation of the proposed technique/methodology will be performed.

PHASE II: A prototype system will be delivered to Arnold Engineering Development Center, TN that will analyze, and propose an optical configuration, assess the residual errors, and produce low cost corrector elements.

PHASE III DUAL USE APPLICATIONS: The commercial market for such a device is extensive. This capability would find marketability in commercial lighting design, medical applications, and optical displays.

REFERENCES:
1. Stone, Thomas, and Nicholas, George, "Hybrid Diffractive-Refractive Lenses and Achromats," ADA201 828 ARO - 24730.6 Rochester University Institute of Optics, July 1988.
2. Gill, Charles W., "Holographic Correction of Aberrations in Optical Systems employing Synthetic Apertures," Masters Thesis, Air Force Institute of Technology, Wright-Patterson AFB School of Engineering, March 1987, ADA 179 107.
3. Hartman Richard L., Guenther, Bob D. "A Holographic Corrector Plate for Laser Designators," Patent Application, Department of the Army Washington DC, Jan 1979.

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AF98-295 TITLE: Advances Short, Mid and Long Wavelength Infrared Detector Material

CATEGORY: BASIC RESEARCH; Sensors

OBJECTIVE: Develop an Innovative Manufacturing Process for Prescribed Wavelength Mercury Cadmium Telluride Focal Plane Array Material.

DESCRIPTION: Advanced short, mid, and long wavelength infrared detectors (which are an integral part of advanced Department of Defense and commercial spacecraft) are becoming increasingly dependent on Mercury Cadmium Telluride (MCT) as the detector material of choice. MCT is an intrinsic detector, allowing operating temperature ranges rather than a fixed point operating temperature. The bandgap (and thus cutoff wavelength) is a function of composition, purity and temperature. This allows MCT crystals to absorb infrared radiation across most of the infrared spectrum, from the near visible to the very long wavelength region. In the short wavelength region, MCT is an environmentally acceptable material, demonstrated to operate in these wavelength regions at temperatures as high as room temperature (300K). In the mid wave region (2-5 microns), MCT absorbs relatively uniformly from 100K to 140K, which can be achieved by radiative cooling. In the long wave region (14-17 microns) MCT has been shown to operate at 40K and 77K. The challenge (which recent indications show can be overcome) of extending the wavelength further, comes through the control of : 1) extreme purity and 2) perceived instability of the mercury-telluride concentration required for such a narrow bandgap. The key to high precision focal plane components, displaying prescribed cutoff wavelengths, adequate yields to meet operability specifications, very low noise, large dynamic range, real time data processing, adequate radiation hardness, etc., lies on development of an innovative, extreme quality, small quantity, cost effective, MCT manufacturing process.

PHASE I: Develop a process to produce a detector wafer in a short period of time, using only several grams of raw material. This process must be highly reliable and allow for a nearly continuous, highly efficient growth operation, flexible enough to change recipes on a shift basis.

PHASE II: Develop a design for a manufacturing facility suitable for short production runs of MCT arrays. Produce a number of sample MCT arrays to prescribed Air Force specifications.

PHASE III DUAL USE APPLICATIONS: In addition to application on advanced DoD/commercial communication spacecraft, application of infrared sensors are of vital concern to advances in geophysical/weather related research. In addition, spin-off technology will be applicable for advanced airborne, terrestrial, and marine navigational equipment, civilian/police night vision equipment, and internal and external security systems, etc.

REFERENCES:
1. Reine, M.B., Norton, P.W., et al. "Independently accessed back-to-back HgCdTe photodiodes. A New Dual-band infrared detector," Proceedings of the 1993 U.S. Workshop on the Physics and Chemistry of Mercury Cadmium Telluride and Other IR Materials, Seattle, WA, 1993. Journal of Electronic Materials v 24 n 5 May 1995, p 669-679.
2. Tennant, W.E., "LWIR HgCdTe: Innovative Detectors in an Incumbent Technology." NASA Report. NTIS No.: N91-14384/2/XAB.
3. Reine, M. B., "Status of LWIR HgCdTe Infrared Detector Technology," NASA Report. NTIS No.: N91-14383/4/XAB.

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AF98-296 TITLE: Infrared Imaging - Phased Array Radar

CATEGORY: Engineering Development; Manufacturing Sciences and Technology (MS&T)

OBJECTIVE: Develop a field deployable system capable of determining the operational status of phased array radar antennas.

DESCRIPTION: Currently there is no available method to field test phased array radar antennas. Mobile Depot Maintenance (MDM) teams are dispatched when-ever a radar has difficulties out of its normal depot maintenance cycle. The teams rely on built-in diagnostics to determine that power is being provided to an antenna phase shifter and on system performance to indicate that the radar is accomplishing its basic function. The built in diagnostics can not indicate if the phase shifter is actually radiating, if it is in phase or its overall effect on antenna performance. If the fault can not be identified, the radar must be returned to the depot for repair. This is both costly and mandates deployment of sometimes unavailable spares. A field deployable test capability would eliminate the unnecessary return to depot for many of these ground based radars. The concept also lends itself to the testing of aircraft radars by allowing them to be tested in place.

The project would be for the development of a field deployable radar test capability which would be able to measure gain, beam steering and phase. The capability should be of easy transport and setup. The unit must be generic in nature; capable of testing without modification or special fixturing, any phased array radar, regardless of frequency or design, in a full power mode. Test results would be computer generated in the typical format of a near field test range.

PHASE I: Develop concept for field testing of phased array radar antennas. Determine test accuracy and limitations. Identify equipment availability and setup requirements inclusive of all support functions. Note that testing is field testing and environmental conditions are subject to extreme change. Identify all personnel and environment requirements and hazards. Cost estimates shall be provided for comparison against current repair techniques. Estimates of setup and test time shall also be provided.

PHASE II: Provide a prototype of the generic field deployable radar test capability and demonstrate first in the laboratory and second in the field, the ability to test gain, beam steering and phase of large phased array radar antennas.

PHASE III DUAL USE APPLICATIONS : Phased array radars are used extensively in commercial aircraft and marine applications. The availability of a field deployable test capability would offer major cost savings by not requiring those carriers to have to remove them from the units for testing.

AF98-297 TITLE: Multi-Color Filter Development for Hardware-In-The-Loop Facility

CATEGORY: Advanced Development; Sensors

OBJECTIVE: Develop a system to accurately control a xenon arc lamp's infrared Band IV/I color ratio.

DESCRIPTION: The evaluation of modern infrared (IR) countermeasures systems requires the presentation of the signatures of military aircraft IR spectrums. A number of DoD and contractor facilities require this capability to effectively design and test new countermeasure systems. The Air Force Electronic Warfare Evaluation Simulator (AFEWES) in Fort Worth, Texas, is a hardware-in-the-loop laboratory used for testing the effectiveness of aircraft protection systems and techniques. The AFEWES provides simulators of surface-to-air and air-to-air missiles and air interceptors for evaluating the effectiveness of countermeasures against these threat systems. The AFEWES provides an IR foreground and background for evaluating infrared countermeasures (IRCM), including flares, jammers, signature reduction, and maneuver. This requirement is for a device and its necessary adjuncts that accurately controls the color ratio of the IR Band IV to IR Band I energy emitted by a xenon arc lamp. This device must be non-powered and fit within the current AFEWES simulation (less then 1/2 inch thick and less than 2 inches in diameter.)

PHASE I: Should result in a proposed system design, feasibility analysis, and a cost analysis. In addition, the vendor should demonstrate the proposed concept at AFEWES. Tradeoff of various methods and placement and installation of these devices is desired.

PHASE II: Develop and install, under the cognizance of AFEWES personnel, a system capable of controlling the color ratio of the IR Band IV to IR Band I energy emitted by a xenon arc lamp. The vendor must deliver a minimum of 20 devices. This device must be non-powered and fit within the current AFEWES simulation as detailed above.

PHASE III DUAL USE APPLICATIONS: This technique is directly applicable as a simulation source for any corporation wishing to simulate IR scenes.

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AF98-298 TITLE: Rapid Generation For Advanced Terrain Visualization

CATEGORY: Advanced Development; Computing and Software

OBJECTIVE: Develop a capability to rapidly generate an advanced terrain visualization database for employment in test, evaluation and training.

DESCRIPTION: The Air Force's move towards a more Modeling and Simulation (M&S) based acquisition process requires advanced tools to aid in the development of simulated environmental data. Complex high resolution terrain database generation is extremely tedious, manpower intensive, and often prohibitively expensive. In the past, M&S support of training did not require high resolution terrain models. However, stringent terrain databases are now required to support the M&S based acquisition and testing developmental process. Innovation is essential for development of a new visual simulation terrain database generation tool to support real-time photo-realistic scenes of a testing environment or engagement area. In addition to a visual fly-through, detailed physical data of the region of interest can provide input into sensor performance models. For example, thermal properties can be used to generate an infrared scene and allow performance predictions of precision guided weapons. Improvements are needed in the level of integration between systems that produce/manage data and the systems that render data. The process by which the topographic data is made available to the rendering system is tedious, slow, and often limited by expensive proprietary constraints. A capability is needed to utilize existing topographic information and improve the access of information available to real-time scene generators and physics-based models. It is anticipated that a structured, object-oriented development environment will be needed to facilitate the employment of domain specific behavior models and an open systems architecture will be used to maximize the overall usefulness of the system design. The key design criteria are: (1) 48 hour data turnaround time, (2) world-wide coverage, (3) geodetic accuracy, and (4) real time display utility.

PHASE I: Research all appropriate technologies and define methods/techniques to construct the appropriate phenomenology database and enable rapid generation and assimilation of topographic/physical information into a single database for real-time scene generation. Investigate potential applicability of existing physics-based models such as IRMA, EOASEL, and XPATCHES. Establish a methodology to ease the linking of domain specific behavior with the visual database. Identify functional processes, scene generator and candidate data sources. Down-select to a single concept to maximize best value system. Prepare verification and validation test plan.

PHASE II: Design, develop and integrate a prototype terrain visualization tool. Validate the system/concept through verification and validation testing. Document results.

PHASE III DUAL USE APPLICATIONS: Multiple commercial applications exist for a rapid terrain visualization tool, such as airline or vehicle crash analysis and visualization, highway traffic simulation and visualization, and urban/rural land-use planning.

REFERENCES: "A Multiresolution Synthetic Environment Based on Observer Viewpoint", Summary Report of 15th Workshop on Standards for the Interoperability of Distributed Simulations, Vol 1.

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DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified 6 technical topics, numbered DARPA SB981-001 through DARPA SB981-006, to which small businesses may respond in the first fiscal year (FY) 98 solicitation (98.1). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical offices.

Please note that **5 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

It is expected that the majority of DARPA Phase I awards will be Firm Fixed Price contracts. Phase I proposals **shall not exceed $99,000**. DARPA Phase II proposals must be invited by the respective Phase I technical monitor (with the exception of projects that qualify for the Fast Track - see Section 4.5). DARPA Phase II proposals must be structured as follows: the first 10-12 months (base effort) should be approximately $375,000; the second 10-12 months (optional effort) should also be approximately $375,000. The entire Phase II effort should not exceed $750,000. It is expected that a majority of the Phase II proposals will be Firm Fixed Price-Level of Effort.

The responsibility for implementing DARPA's SBIR Program rests with the Office of Administration and Small Business (OASB). The DARPA SBIR Program Manager is Ms. Connie Jacobs. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714

(703) 526-4170
Home Page http://www.darpa.mil

SBIR proposals will be processed by DARPA OASB and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., "The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution" (refer to section 4.2 Evaluation Criteria - Phase I - page 7), twice the weight of the other two evaluation criteria. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the closing date of this solicitation. For contractual purposes, proposals submitted to DARPA should include a statement of work which does not contain proprietary information. Successful offerors will be expected to begin work no later than 30 days after contract award. For planning purposes, the contract award process is normally completed within 30 to 60 days from issuance of the selection notification letter to Phase I offerors.

On a pilot basis, the DoD SBIR program has implemented a streamlined Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort, as well as for the interim effort between Phases I and II. Refer to Section 4.5 for Fast Track instructions. DARPA encourages Fast Track Applications between the 5th and 6th month of the Phase I effort. Technical dialogue with DARPA Program Managers is encouraged to ensure research continuity during the interim period and Phase II. If a Phase II contract is awarded under the Fast Track program, the amount of the interim funding will be deducted from the Phase II award amount. It is expected that interim funding will not exceed $40,000.

DARPA 1998 Phase I SBIR
Checklist

1) Proposal Format

a. Cover Sheet - Appendix A (identify topic number) ______

b. Project Summary - Appendix B ______

c. Identification and Significance of Problem or Opportunity ______

d. Phase I Technical Objectives ______

e. Phase I Work Plan ______

f. Related Work ______

g. Relationship with Future Research and/or Development ______

h. Commercialization Strategy ______

i. Key Personnel, Resumes ______

j. Facilities/Equipment ______

k. Consultant ______

l. Prior, Current, or Pending Support ______

m. Cost Proposal (see Appendix C of this Solicitation) ______

n. Company Commercialization Report - Appendix E ______

2) Bindings

a. Staple proposals in upper left-hand corner. ______

b. **Do not** use a cover. ______

c. **Do not** use special bindings. ______

3) Page Limitation

a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

b. Beyond the 25 page limit do not send appendices, attachments
and/or additional references. ______

c. Company Commercialization Report (Appendix E) is not included in the page count. ______

4) Submission Requirement for Each Proposal

a. Original proposal, including signed Appendices A and B. ______

b. Four photocopies of original proposal, including signed Appendices A ,B and E. ______

INDEX OF DARPA FY98.1 TOPICS

SUBJECT/WORD INDEX TO THE DARPA FY98.1 TOPICS

DARPA 98.1 TOPIC DESCRIPTIONS

DARPA SB981-001 TITLE: Littoral Warfare Mine Hunting and Mapping

CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop and demonstrate a prototype mine hunting and mapping system to effectively detect, classify, and map mines and other obstacles in very shallow water and the surf zone. The proposed system should include a suite of sensors and the associated necessary signal processing to perform the detection, classification, and mapping tasks. It should interface with an unmanned platform/vehicle for needed mobility.

DESCRIPTION: To ensure effective safe operations in the littoral, a remote assessment of the mine threat in very shallow water and the surf zone is required. This will permit operational vessels to safely approach hostile shore areas to support a successful attack/landing. This operating environment is very complex and includes colloid suspensions in the water column, bubbles, and water movement caused by the surf. Both the sensor suite and its associated platform can be adversely affected by this unfriendly environment. DARPA, through this SBIR topic, seeks proposals to identify a prototype system that will address this problem in its totality. A successful submission will consider both the sensor suite with appropriate signal processing and the unmanned vehicle to provide safe standoff of the associated supported vessels. A conventional towed behind device tethered to a blue water vessel is not desired. The system should provide a safe channel that is 50 meters wide, and progress at a minimum SOA of 2 km/hr with all mines and minelike objects identified, and accurate positions given, to provide a safe lane in which ships can perform their assigned missions. The unmanned platform can be free swimming, bottom crawling, or other appropriate transporter, preferably autonomously or remotely operated. Sensor suites can be acoustic, nonacoustic, or a combination thereof at the discretion of the proposer. For demonstration purposes, real-time embedded computing for signal processing need not be addressed, but platform guidance and control will.

PHASE I: Using an existing database, model the performance effectiveness of the proposed vehicle and sensor suite and supporting detection, classification, and mapping algorithms. Demonstrate through modeling/simulation the capability of the unmanned platform to successfully operate in the unfavorable environment.

PHASE II: Construct a prototype system and demonstrate its sensor suite and signal processing capabilities and the platform's shallow water and surf zone maneuverability and suitability.

PHASE III DUAL USE APPLICATIONS: The technologies associated with high resolution mine mapping also provide a capability to produce a high resolution image of the ocean floor. Such imagery would be useful for fisheries studies, sea floor pipeline locating, salvaging operations, and in certain environmental cleanup efforts.

DARPA SB981-002 TITLE: Free-Flight Demonstration of Hypersonic Air-Breathing Supersonic Combustion Ramjet (SCRAM) Propulsion

CRITICAL TECHNOLOGY AREA: Aerospace Propulsion and Power

OBJECTIVE: Develop a low-cost, near term demonstration of sustained air-breathing flight at Mach ≥ 6 and obtain flight environment data for validation of simulations of the flight conditions.

DESCRIPTION: The program should comprise the design, fabrication, and testing of flight articles and related diagnostics. The design and data analysis activities will be conducted in cooperation with government agencies as directed by the sponsor. Maximum use of commercially available "off-the-shelf" hardware and economical manufacturing techniques should be employed. This program is expected to lead to the advancement of technology for production of a high speed, affordable, stand-off missile and, ultimately, to a manned hypersonic transport for commercial and military use.

PHASE I: This phase encompasses the design and critical component testing of a gun-launched scram projectile and associated on-board diagnostics. The projectile and payload will be designed to survive launch loads in excess of 20 kg and to demonstrate thrust $\geq$ drag at Mach and Reynolds number appropriate to an operational free flight (80Kft, Mach ≥ 6) demonstration. The miniature on-board instrumentation will provide 10 data channels, including acceleration, pressure, and temperature. The program plan should include two trips to the managing program office and identification of potential flight test facilities.

PHASE II: This phase involves manufacture and free-flight testing of the Phase I design. Five flight articles will be fabricated and tested at an appropriate hypervelocity launch facility. Critical demonstrations include mechanical integrity, stable free-flight, inlet start, fuel release and ignition, and flight data acquisition.

PHASE III DUAL USE APPLICATIONS: The development and demonstration of an air-breathing hypersonic engine will lead to commercial applications such as civil hypersonic transport and space launch. This air-breathing propulsion technology is critical to high speed bomber and transport propulsion systems.

DARPA SB981-003 TITLE: Collaborative Engineering Decision Support for Distributed Design of Complex Electro-Mechanical Products

CRITICAL TECHNOLOGY AREA: Manufacturing Science and Technology (MS&T)

OBJECTIVE: Define, design, and demonstrate an Engineering Decision Support (EDS) computer tool to support multi-disciplinary, distributed design teams through the decision making process.

DESCRIPTION: Design of complex electro-mechanical products is comprised of an evolution of information which begins with an incomplete definition of need for such products, and ends with exact specifications for the product's manufacture, operational use, and disposal. In the development of this information, key decisions are made which define the product evolution and ultimately determine the product's acceptance by the customer. Current design systems are limited in guiding multi-disciplinary teams through the decision making process. Also lacking are automated capabilities which can exploit methods such as Quality Function Deployment (QFD) and Design of Experiments (DOE).

This topic seeks to extend current capabilities to: a) support the capture of customer requirements; b) provide methods to map requirements to engineering specifications; c) enable capture of design rationale and support the integration of results from analytical evaluation or experiments into the design rationale; d) support multi-disciplinary design teams in coming to consensus; e) support the recovery of design rationale by providing mechanisms for organizing, sorting, retrieving, and communicating to a product database; and f) support distributed teams through the use of the internet.

PHASE I: Define the architecture and key components of the EDS tool to support the topic objective.

PHASE II: Prototype and demonstrate the EDS tool defined in Phase I by exercising its functionality through the use of a complex electro-mechanical product design scenario.

PHASE III DUAL USE APPLICATIONS: The availability of a design tool that structures and captures design information while assisting design teams in making decisions and directing them toward their next decision would be attractive to both defense and commercial sectors.

DARPA SB981-004 TITLE: Three-Dimensional Matrices for Cellular and Multicellular Biointerfaces

CRITICAL TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Creation of three-dimensional environments for the controlled spatial orientation enabling efficient transport, supporting metabolism and differentiation and long-term stability of biological cells.

DESCRIPTION: Research and development leading to the fabrication of three-dimensional materials that support the function of cellular and multicellular biological components. Efforts may address any class of materials that is compatible with biological function including hydrogels, silicones, ceramics, or plastics and may address modification of existing materials or design and synthesis of new materials. Development areas of interest include efficient bioreactor designs, materials that support adhesion, growth and differentiation of biological cells including stem cells, neurons, endothelial cells, and monocytes.

PHASE I: In detail, define the material and the cell type application, the approach to demonstration of biocompatibility and cellular performance and the expected benefits of the material.

PHASE II: Fabricate material and cell constructs that demonstrate long-term multicellular function. Optimize the material properties to include transport of nutrients and wastes within the matrix and the processing of information from the detection and response to chemical and biological agents. Limitations of the system with regard to dimensionality of the matrix and constraints to cellular function must be defined. Complete documentation of test cases and results must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of a three-dimensional matrix for the spatial orientation of biological cells will expand the commercial market for multicellular based biosensors and bioreactors for the efficient production of terminally differentiated cells or other biological products of cells. Dramatic improvement in biocompatibility of materials and improved cellular function will be enabled by defining and fabricating new three-dimensional materials.

DARPA SB981-005 TITLE: Lifting Vehicle for Forward-Deployed Combat Units

CRITICAL TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Provide a means for forward-deployed troops to elevate a sensor for local area surveillance and other missions.

DESCRIPTION: A system for elevating a 5-25 pound payload up to 300ft above ground level is needed to support forward-deployed combat units. The technology sought is the lift system, the deployment system, and the control system. Fixed-wing, rotary-wing, and lighter-than-air systems may be considered. Automatic station-keeping and greater than 2 hours time-on-station are required. The payloads of interest would provide situational awareness, Combat ID, IFF, and communications relay for forward area troops.

PHASE I: Design a prototype lifting body/structure and its transportation, deployment, and stowage systems. Predict lift altitude/payload weight capacity, size/weight/power requirements, and deployment/stowage times. Perform hardware risk reduction for critical technologies.

PHASE II: Build a prototype of the system with support equipment required for a demonstration deployment of a dummy payload. Exercise the lift weight/altitude performance profile and time-on-station capability. Report on production considerations and lessons learned from the prototype.

PHASE III DUAL USE APPLICATIONS: Commercial surveillance and security operations as well as law enforcement and emergency rescue agencies have a need for lifting bodies capable of elevating short-range sensors. Additionally, national border and coastal surveillance agencies could significantly enhance their missions through such a system.

DARPA SB981-006 TITLE: Lightweight Imaging Sensor System

CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Design, develop and demonstrate an all weather, lightweight, low-cost, distributed-component sensor suite suitable for deployment on a small, lighter-than-air, stationary airborne platform.

DESCRIPTION: Lightweight imaging sensors, which have remote signal processing, displays and controls for use by forward-deployed combat units and overseas garrison security forces are required for integration on small, mobile lifting bodies. This sensor suite must provide image data of sufficient sensitivity and resolution to detect ground vehicles, personnel, and low-flying aircraft at ranges up to 15km during both fair and limited visibility conditions. The sensor must be capable of operation from small, stationary lifting bodies with payload capacities less than 50 pounds. The sensor suite should operate day or night, in smoke and haze, and in rain with graceful degradation and not require more than .5 KVA of prime power. Additionally, this sensor suite must be designed with low-cost in mind. As a goal, the cost for 10 low rate initial production models should not cost more than $150K. It is envisioned that the innovative use of advanced composites, low-cost manufacturing techniques, and application of space based sensor technologies will be considered. There are currently no systems capable of meeting this need.

PHASE I: Design a prototype sensor suite with separable modules for the sensor head, data up/down link, signal processor, displays and controls. The prototype gear should have representative performance, but need not be form-factor. A report giving production weight and power budgets, performance estimates and a demonstration program plan is required.

PHASE II: Develop and integrate a prototype sensor with a GFE lifting body and ground mobility platform, i.e. HUMMWV, for a live demonstration program. Test the sensor suite and deployment mechanisms as a system, and provide a phenomenology and system performance report. A system description for a production item is also provided.

PHASE III DUAL USE APPLICATIONS: Lightweight imaging sensors have multiple applications as do the technologies to separate the signal processing, control and display functions. The immediate use of this technology is to support the recently formed Special Security Forces who will conduct surveillance, intelligence and security operations for US forces deployed overseas. Concurrently, this technology will be modeled by the US Army Mounted Warfare Battle Lab for concept development and force design analysis for potential use by its Cavalry and Scout units. Additionally the Marine Corps's Commandant's Warfighting Laboratory is interested in this technology for use in supporting Expeditionary Warfare Operations. Also, many commercial surveillance and security requirements could be addressed by these technologies. National border and coastline surveillance, as well as traffic management functions, could be enhanced by the application of such lightweight, low-cost, mobile systems.

DEFENSE SPECIAL WEAPONS AGENCY

The Defense Special Weapons Agency (DSWA) is seeking small businesses with a strong research and development capability and experience in nuclear weapons effects, phenomenology, operations and counterproliferation. (Note we are not interested in nuclear weapons design or manufacture.) DSWA invites small businesses to send proposals to the following address:

Defense Special Weapons Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, Virginia 22036-3398

The proposals will be processed and distributed to the appropriate technical offices for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Special Weapons Agency
ATTN: AM/SADBU, Mr. Bill Burks
6801 Telegraph Road
Alexandria, Virginia 22036-3398
(Telephone: 703-325-5021)

DSWA has submitted 29 technical topics numbered DSWA 98-001 through DSWA 98-029. These are the only topics for which proposals will be accepted. The current topics and topic descriptions are included hereafter. These topics were initiated by the DSWA technical offices which manage the research and development in those areas. Several of the topics are intentionally broad to ensure innovative ideas which fit within DSWA's mission are submitted. Proposals do not need to cover all aspects of the broad topic. Technical questions concerning the topics should be submitted to:

Defense Special Weapons Agency
ATTN: AM/PMX, Mr. Ronald Yoho
6801 Telegraph Road
Alexandria, Virginia 22036-3398
(Telephone: 703-325-6475)

DSWA selects proposed for funding based on the technical merit, criticality of the research, and the evaluation critiera contained in this solicitation. Funding is limited, therefore, DSWA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and filling the most critical requirements. As a result, DSWA may fund more than one proposal under a specific topic or it may fund no proposals in a topic area. Proposals which cover more than one DSWA topic should only be submitted once.

DSWA has not set aside funds for bridge funding (with the exception of projects that qualify for the Fast Track - see Section 4.5 of this solicitation). Therefore, proposers should not rely on bridge funding to cover the time gap between Phase I and award of Phase II.

DEFENSE SPECIAL WEAPONS AGENCY
FY 1998 SBIR TOPIC INDEX

Chemical and Bilogical Defense (and Nuclear)

DSWA98-001	Nuclear Weapons Effects on Electronics
DSWA98-002	Pulsed Power Technology and Applications
DSWA98-003	X-Ray Effect Simulation Technology
DSWA98-004	Instrumentation and Diagnostics
DSWA98-005	Radiation Hardening of Microelectronics
DSWA98-022	Nuclear Weapons Effects Phenomenology

Command, Control and Communications (C3)

DSWA98-016	High Speed Non Line of Sight Wireless Data

Computing and Software

DSWA98-009	Smart Archive Search and Presentation Methods
DSWA98-010	Automated Data Capture and Metadata Creation for a Digital Data Archive
DSWA98-011	Use of Digital Video for Archiving Technical Information
DSWA98-012	Metadata Modeling Produce for Data Engineering
DSWA98-013	Digitizing and Archiving of High Speed Cinematographic Film
DSWA98-014	Evaluation and Archival of Nuclear Weapons Effects
DSWA98-019	Multi-Source Data Fusion for Monitoring to Detect Nuclear Tests
DSWA98-020	Tracking Atmospheric Plumes Based on Stand-Off Sensor Data
DSWA98-021	Multi-Dimensional Visualization of Data to Identify Seismic Events or for Other Complex, Multi-Dimensional Data Problems
DSWA98-023	Nuclear Collateral Effects

Conventional Weapons

DSWA98-002	Pulsed Power Technology and Applications
DSWA98-017	Conventional Weapons
DSWA98-024	Advanced Lethality Technologies

Electronics

DSWA98-005	Radiation Hardening of Microelectronics
DSWA98-008	Field Expedient Hardening

Materials, Processes and Structures

DSWA98-006	Materials Response

Modeling and Simulation (M&S)

DSWA98-015	Nuclear Weapons System and WMD Demilitarization Assessments/Special Studies
DSWA98-025	Structure Design Software Tools
DSWA98-026	Enhance Imaging/Search Modeling and Simulation Technology
DSWA98-027	Low Frequency Magnetic Signatures for Detecting and Discriminating Nuclear/Nonnuclear Underground Tests
DSWA98-029	Human Response Models for Performance and Risk Estimation

Sensors

DSWA98-005	Radiation Hardening of Microelectronics
DSWA98-007	Smart Optics
DSWA98-018	Detection of Minute Intrusion
DSWA98-028	Nuclear Weapons Effects Phenomenology

DSWA SUBJECT WORD INDEX

SUBJECT **Topic Number**

DSWA 98.1 TOPIC DESCRIPTIONS

DSWA 98-001 TITLE: Nuclear Weapon Effects on Electronics

KEY TECHNOLOGY AREA: Nuclear, Chemical and Biological Defense

OBJECTIVE: Explore the effects produced by nuclear radiation and electromagnetic pulse on electronics

DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear-weapon produced radiation and natural radiation on electronics, electronic systems, photonics devices, and sensors in the areas of- a) Transient Radiation Effects on Electronics (TREE); b) High Altitude Electromagnetic Pulse; (HEMP); c) System Generated EMP (SGEMP); and d) Source Region EMP (SREMP) are of interest to DSWA. Particular areas of concern include: methods by which designers of space, strategic and tactical systems can assess their susceptibility to these effects; technologies to reduce the susceptibilities of electronic systems and microelectronics/photonics devices (especially those with submicron feature sizes); and methods to demonstrate survivability under specified threat criteria. Concepts and techniques to improve the survivability (decrease the response) of systems against these nuclear weapons effects are required. In addition, concepts and techniques to model the nuclear radiation and electromagnetic system effects in the distributed interactive simulation (DIS) format are required.

PHASE I: Initial feasibility studies will be completed to demonstrate the viability of the proposed approach.

PHASE II: Continue the investigation that was begun in Phase I to fully demonstrate the proposed approach using a prototype concept demonstration.

PHASE III DUAL USE APPLICATIONS: Nuclear survivable electronics will be useful; for military and commercial satellites, for nuclear power systems, system with electromagnetic interference and electromagnetic compatibility requirements.

REFERENCES:
(1) DNA EM-1, Capabilities of Nuclear Weapons, Chapter 11, “TREE” and Chapter xx, “Electromagnetic Pulse Effects
(2) Glasstone, The Effects of Nuclear Weapons

DSWA 98-002 TITLE: Pulsed Power Technology and Applications

KEY TECHNOLOGY AREA: Nuclear, Chemical and Biological Defense; Conventional Weapons

OBJECTIVE: Dramatic improvements in energy storage, switching, and power conditioning technologies.

DESCRIPTION: Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance over the existing state of the art. Innovative approaches for component or subsystems development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more energy efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed power technologies include those that operate at kilovolts to megavolts, kiloamperes to megaamperes, and have repetition rates fro single pulse to 10 kilohertz to meet the DoD applications such as armor/anti-armor; electromagnetic/electrothermal guns; mine/countermine; air, surface, and subsurface systems; high power microwave weapons; etc. Development of new diagnostics used to enhance the operation of the various pulsed power elements are required.

PHASE I: demonstrate the feasibility of the proposed concept.

PHASE I:, develop, test, and evaluate proof-of-principle hardware.

PHASE III DUAL USE APPLICATIONS: In addition to the DoD applications cited, these pulse power component technologies will be useful in cleaning up smoke stack effluents, general environmental pollution control, metal cutting, and electric vehicles.

REFERENCES:
(1) Radiation Test Facilities and Capabilities, 1997, DASIAC, 2560 Huntington Ave., Alexandria, VA 22303.
(2) J. C. Martin on Pulsed Power, Edited by T. H. Martin, A. H. Guenther, and M. Kristiansen, Plenum Press, New York and London, 1996, ISBN 0-306-45302-9

DSWA98-003 TITLE: X-Ray Effect Simulation Technology

KEY TECHNOLOGY AREA: Nuclear, Chemical and Biological Defense

OBJECTIVE: Develop innovative technologies for the production of x-ray radiation.

DESCRIPTION: Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts for producing soft x-rays (1-5 keV), warm x-rays (5-15 keV), and hot x-rays (>15 keV). Soft x-rays are used for optical and optical coatings effects testing. Warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.

Present Plasma Radiation Source (PRS) generate copious amounts of debris (material, atomic charged particles, sub-keV photons). Debris production is an even greater concern for the simulators currently under development. New measurement and analysis technologies are required to characterize the source and the debris generated from wire array and z-pinch PRS to better understand debris sources and mitigation. Existing debris shield technologies are not adequate to support larger exposure areas and cleaner test environments while minimizing fluence degradation. New methods, or combination of methods, need to be developed to stop, mitigate, and/or delay debris generated for radiation simulators.

New technologies to measure plasma parameters for simulator sub-systems such as plasma opening switches and plasma sources are of interest. Test response diagnostic technologies are required to measure the full time and spectral history of the radiation pulse across the breadth and width of the test asset as well as the response of the test asset during and after irradiation. Pulsed power diagnostic technologies are required for accurate, in-situ measurement of voltages and currents within the various simulator subsystems in order to monitor and characterize simulator performance. Diagnostic systems include required sensors/detectors, cabling, recording equipment and media, and if necessary, computer systems and software

New concepts for compact x-ray sources for component level nuclear weapons effects x-ray testing are also of interest. DSWA is seeking innovative approaches for cost effective, compact pulsers with low end point voltage x-rays (100-500 keV) for possible operation at service customer production facilities.

PHASE I: demonstrate the feasibility of the proposed concept.

PHASE II: develop, test and evaluate proof-of-principle hardware in its working environment on a radiation simulator. This will involve coordination with DSWA to schedule testing in an above ground test simulator.

PHASE III DUAL USE APPLICATIONS: In addition to the applications cited for developing the environments for simulating the effects of nuclear weapons, the technologies will be useful with the commercial operations of nuclear instrumentation, very fast closing valves, material surface treatments, environmental clean-up and high brightness x-ray sources.

REFERENCES:
(1) DNA INWET conference Announcement Brochure, 1993 and 1991
(2) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(3) DNA EM-1, Capabilities of Nuclear Weapons
(4) Radiation Test Facilities and Capabilities, 1997, DASIAC, 2560 Huntington Ave., Alexandria, VA 22303

DSWA 98-004 TITLE: Instrumentation and Diagnostics

KEY TECHNOLOGY AREA: Nuclear, Chemical and Biological Defense

OBJECTIVE: Advance the state of the art in nuclear and conventional weapon effects instrumentation.

DESCRIPTION: Instrumentation is used for measuring nuclear and conventional weapons effects including: phenomenology parameters and the response of test items exposed to conventional or simulated nuclear weapons effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in blast and shock tests, or tests involving high levels of X-ray, gamma, or neutron radiation. Instrumentation is needed for the following types of tests: airblast, ground shock, dusty flow, dust lofting, water shock, shock propagation in rock, High Explosive (HE), nuclear radiation (x-rays and gamma rays), thermal radiation, electromagnetic pulse (EMP) (high altitude or system generated) and for improved data acquisition (transmission and recording). Desirable improvements include costs, ease of use, precision, accuracy, reliability, ease of calibration (preferably on site) and maintainability. Some current problems are the ability to make airblast and thermal measurements in an explosive debris environment, machine explosive characterization measurements inside the high explosive itself during detonation, and full characterization of debris (size and momentum) from encased explosive detonations.

PHASE I: build a prototype instrument or instrument system and demonstrate its performance in laboratory scale testing.

PHASE II: design build and test a full-scale instrument system demonstrating its performance in its intended working environment. This may involve coordination with DSWA to schedule testing in a simulator.

PHASE III DUAL USE APPLICATIONS: In addition to the applications cited for measuring the environments for simulating the effects of nuclear and conventional weapons and for developing these environments, the technologies will be useful with the commercial operations of metrology, blasting, earthquake studies, radiation testing/monitoring, large structure integrity, fire protection, lightning protection, and hazardous waste containment.

REFERENCES:

(1) DNA INWET conference Announcement Brochure, 1993 and 1991
(2) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(3) DNA EM-1, Capabilities of Nuclear Weapons
(4) Radiation Test Facilities and Capabilities, 1997, DASIAC, 2560 Huntington Ave., Alexandria, VA 22303

DSWA 98-005 TITLE: Radiation Hardening of Microelectronics

KEY TECHNOLOGY AREA: Chemical and Biological Defense and Nuclear; Sensors and Electronics

OBJECTIVE: Develop and demonstrate microelectronics technology to: (1) radiation harden; (2) improve reliability and electrical performance; (3) improve radiation hardness and reliability assurance methods; and (4) develop radiation - performance predictive device and circuit models and (5) characterize the radiation and reliability response of semiconductor devices (microelectronics and photonics) including warm and cold operation complementary metal oxide semiconductor (CMOS), bipolar, and compound material technologies.

DESCRIPTION: The trend in microelectronics and photonics devices is toward higher levels of integration density, higher speeds, higher circuit complexity, lower voltage and power, and larger die size and radiation tolerance. All of these trends have exacerbated the problems associated with radiation hardening, electrical performance, reliability, testability, producibility and affordability. In addition, improvements in material science have lead to the introduction of a wide variety of compound semiconductor materials into microelectronics and photonics devices. The radiation and reliability responses of these materials and devices is lacking or unknown.

Thus, innovative technology and methods are required that: (1) ensure that microelectronics and photonics can operate in a radiation or other stressing environment (e.g., very high or low temperatures); (2) improve radiation-hard device reliability; (3) improve producibility and yield of radiation hard processes; (4) develop cost-effective hardness and reliability assurance methods; (5) develop radiation performance predictive models for devices and circuits: (6) investigate and characterize the radiation response and reliability performance of these devices and associated materials; and (7)establish electronic design automation methods to facilitate the transfer of commercial designs to radiation-tolerant technology. The development of methods to improve the survivability of

PHASE I: Initial feasibility will be demonstrated of the proposed technology and proposed hardening approach.

PHASE II: Continue the investigation that was begun in Phase I to fully demonstrate the proposed approach or develop a prototype that reduces the concept to engineering practice.

PHASE III DUAL USE APPLICATIONS: Radiation-tolerant microelectronics will be useful for military and commercial satellites and missiles and f or nuclear power systems. The development of radiation tolerant microelectronics that enhance performance, reliability, producibility, and yield will also support the commercial electronics sector.

REFERENCES:

(1) DNA EM-1, Capabilities of Nuclear Weapons, Chapter 11, "TREE"
(2) Glasstone, The Effects of Nuclear Weapons

DSWA 98-006 TITLE: Materials Response

KEY TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Investigate material responses to nuclear weapons for strategic and tactical applications.

DESCRIPTION Recent changes in material manufacturing techniques and requirements have produced new materials that may or may not be radiation hard. Materials and structures used in nosetips, coatings, airfoils, tanks, packages, reflectors, housings, windows and antennae must be evaluated.

PHASE I: Survey materials and structures developments for lightweight composites, mylar films, rubber bladders, C-cloth, PLZT multilayers, SiC and Be lightweight mirrors, polymides, BN composites, honey combed composites and impregnated materials. Develop a test methodology, physical model and test coupon or witness sample that can be used to determine radiation response of the materials and structure.

PHASE II: Develop a plan to evaluate two sets of application specific structures and materials. Manufacture material in a type application structure, characterize the material, develop predictive model of radiation response of the materials and structures. Expose the material to radiation while performing in-situ test. Evaluate the threshold or on-set of radiation damage. Provide test data to validate theoretical model from at least two simulators, one of which must be an x-ray simulator.

PHASE III DUAL USE APPLICATIONS: Materials and structures are a dual-use multi-application field. Mechanical, electrical and optical components are critical to a military that uses technology as a force multiplier. Intelligent selection of materials for mission requirements will play a role in the development of cost-effective and reliable solutions for military needs. Dual use applications will be provided in light-weight materials that ameliorate adverse environments caused by fire, smoke, dust and rain.

DSWA 98-007 TITLE: Smart Optics

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Replace filters and lenses with fast, tunable band pass filters for multispectral response.
Investigate radiation hardness of the materials.

DESCRIPTION: Sensor systems will be required to be light-weight and robust. Smart optics can be achieved by placing SBN, ZnO and PLZT multilayers for wavelength selection in the optical train. Evaluation of the component for radiation effects is crucial first step to development of smart optics.

PHASE I: Develop a candidate smart optic subsystem for the UV or LWIR wavelengths. Develop a test methodology to demonstrate operation of a radiation environment caused by debris gammas and trapped electron environments.

PHASE II: Fabricate a developmental tunable band pass filter smart optic that can demonstrate the theoretical improvements. Perform optical tests to determine operational characteristics. Characterize the system after exposure to gamma and x-ray environments.

PHASE III DUAL USE APPLICATIONS: Smart optics in the UV and LWIR applications can be used for various space platforms for monitoring solar flares and environmental problems.

DSWA 98-008 TITLE: Field Expedient EMP Hardening

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop innovative methods that would temporarily harden military and civilian electronic equipment to electromagnetic pulse (EMP) effects.

DESCRIPTION: Commercial Off the Shelf (COTS) products are being used in more and more military systems. COTS products are not inherently designed for immunity to EMP effects. In addition, critical elements of the commercial infrastructure (i.e., telephone, power) may possess vulnerabilities to EMP. Innovative methods to temporarily harden military and essential civilian electronic equipment to the effects of EMP (E1, E2, E3, and SREMP) are of interest. Installation should be relatively easy and quick (hours to a few days) and provide protection for several months to a year. Such hardening methods must be practical for field equipment and allow operation of the system.

PHASE I: Develop concept feasibility through either analysis or laboratory scale demonstration.
PHASE II: Further develop through more definitive experiments and/or field demonstrations.

PHASE III DUAL USE APPLICATIONS: Electromagnetic Interference (EMI) and Electromagnetic Compatibility(EMC), lightning protection.

REFERENCES: MIL-STD-188-125, MIL-HDBK-423

DSWA98-009 TITLE: Smart Archive Search and Presentation Methods

KEY TECHNOLOGY AREA: Computing and Software (intelligent systems, user interface)

OBJECTIVE: Develop innovative technologies for the intelligent search, presentation and relating of data and objects within a digital archive.

DESCRIPTION: The Defense Special Weapons Agency (DSWA) is interested in improving the search and knowledge extraction capabilities of its Nuclear Weapons Effects archival database, the Data Archival and Retrieval Enhancement (DARE) system. DSWA has invested heavily in the acquisition of a comprehensive collection of unique and irreplaceable nuclear weapon effects information in such varied forms as reports/documents, photographs, film, waveforms, tables and diagrams. DSWA is keenly aware of the risk to the preservation of this legacy information, gathered at great cost and effort, as budgets and human and capital resources are reduced. In the post-Cold War environment with no new data from nuclear testing expected and nuclear data experts rapidly retiring, the ability to rapidly find, display, correlate and analyze this material via DARE is increasingly crucial to future research efforts which will rely more on simulations and high fidelity calculations coupled with correlation with the archived data. Thus innovative, value adding tools are required to relate and extract knowledge from the collection.

PHASE I: demonstrate the value added the technology offers and the feasibility of incorporating the proposed technology into DARE and develop an implementation plan.

PHASE II: implement the developed technology into DARE's search and navigation mechanisms.

PHASE III DUAL USE APPLICATIONS: Improved archive search technologies apply directly to a large and fast growing civilian market involving digitized workflow, data archiving and data mining technologies. A possible follow-on would be to adapt the technology to access remote databases and archives.

DSWA98-010 TITLE: Automated data capture and metadata creation for a digital data archive

KEY TECHNOLOGY AREA: Computing and Software (software and systems development)

OBJECTIVE: Explore and develop innovative, automated and low-cost methods for the digital capture and storage of documents and creation of associated metadata for a data archive.

DESCRIPTION: The digital capture and storage of documents into the Defense Special Weapons Agency's data archival system has proven to be slower and more costly than anticipated. In particular, the creation of metadata labels for the digitally captured documents and material, a manual and time intensive process, has limited archive population. While information for label creation is available from different digital sources such as the agency's STILAS database, data integrity issues have limited implementation of this information into metadata labels.

PHASE I: research will demonstrate the feasibility of an automated method for creation of archive metadata labels which significantly improves the rate of metadata label production.

PHASE II: implement the developed technology and procedures into the DSWA's data archiving effort.

PHASE III DUAL USE APPLICATIONS: Suggested research is applicable to many current data transfer problems in both government and civilian sectors such as transferring data between dissimilar databases and tools for linking remote archives with different metadata.

DSWA98-011 TITLE: Use of Digital Video for archiving technical information

CATEGORY: Computing and Software (software and systems development, user interface)

OBJECTIVE: Explore and develop innovative methods for storing, retrieving, displaying and transferring digital video for use in a digital archive program.

DESCRIPTION: As part of its stewardship program, the Defense Special Weapons Agency is involved in the digital archival of video. This effort includes capturing legacy film, but also includes the videotaping of experts involved in technical discussions germane to Nuclear Weapons Effects research. Storing digitized video, searching and analyzing the subject film and associated audio and transferring these typically large files are challenging research areas which offer a large return in the capability of data archival systems to maintain useful video collections.

PHASE I: research will demonstrate the feasibility of a proposed technology to improve digital video archiving.

PHASE II: implement the developed technology and procedures into the DSWA's data archive system.

PHASE III DUAL USE APPLICATIONS: Suggested research is applicable to many current data transfer and archival problems in both government and civilian sectors. Follow on applications might include x-ray diagnosis/analysis tools and smart military imagery analysis tools for targeting.

DSWA98-012 TITLE: Metadata modeling product for data engineering

CATEGORY: Computing and Software (software and systems development)

OBJECTIVE: Explore and develop an innovative modeling method for the process of engineering metadata for new data types within the Defense Special Weapon Agency's (DSWAs) Data Archival and Retrieval Enhancement (DARE) system.

DESCRIPTION: Efforts are currently underway to define the numerous numeric data types which will eventually be in the DARE system. The DARE system uses Object Definition Language to define metadata. The current process is extremely time and labor intensive, requiring considerable domain expertise.

PHASE I: research will demonstrate the feasibility of a proposed technology to streamline and improve the process of creating metadata fields for new data types for the DARE system.

PHASE II: implement the developed technology and procedures into the DARE Data Engineering process.

PHASE III DUAL USE APPLICATIONS: Suggested research is applicable to virtually all data archives, both government and civilian.

DSWA98-013 TITLE: Digitization and archiving of high speed cinematographic film

CATEGORY: Computing and Software (software and systems development)

OBJECTIVE: Explore and develop an innovative and cost effective method for digitizing high speed cinematographic film.

DESCRIPTION: The Defense Special Weapons Agency (DSWA) currently has numerous high speed cinematographic films documenting fireball effects from nuclear tests. These old specialized films must be carefully handled due to their age and require special digitization techniques to ensure resolution is retained in digital form. Current technology involves capturing each video frame as a TIFF file and linking the associated files, a timely intensive and costly process.

PHASE I: research will demonstrate the feasibility of a cost effective new method and/or technology to streamline and improve the process of digitizing high speed scientific film without sacrificing resolution quality.

PHASE II: implement the developed technology and procedures into the DARE Data Engineering process.

PHASE III DUAL USE APPLICATIONS: Suggested research is applicable to virtually all data archives, both government and civilian. Technology may be specifically applied to the digital archiving of collections of valuable photographic negatives where resolution is a concern.

DSWA98-014 TITLE: Evaluation and Archival of Nuclear Weapon Effects Material

KEY TECHNOLOGY AREA: Computing and Software (user interface)

OBJECTIVE: Development of innovative products, systems, evaluation methods, electronic archival methods, location and retrieval methods and distribution methods for the preservation and use of nuclear weapons effects material.

DESCRIPTION: Specific objectives are to capture nuclear weapon effects test data, identify, prioritize, and caveat test data for transfer to digital archives. Objectives can also be to design information retrieval and storage systems which are user friendly and accessible.

The Department of Defense has invested heavily in the acquisition of a comprehensive collection of unique and irreplaceable nuclear weapon effects information in such varied forms as reports/documents, photographs, film, waveforms, tables and diagrams. This legacy information, gathered at great cost and effort is at risk, as budgets and human capital resources are reduced. Access to this irreplaceable database is crucial to future national security needs that will rely more on simulations and high fidelity calculations. Improved methods are required for the management of technical information that relates to archival of nuclear weapon phenomenology and test data as well as input to and retrieval of such data.

PHASE I: the research will demonstrate the feasibility of the proposed approach to improve the understanding of nuclear weapon effects or the archival and ease of retrieval and use of stored data.

PHASE II: the research concepts developed in phase I will be further developed and incorporated into existing DSWA electronic archival systems.

PHASE III DUAL USE APPLICATIONS: Electronic filing and data retrieval is the touchstone of this information age. The output of this SBIR could have tremendous potential to further the understanding of how to improve current systems and the design of future systems.

DSWA98-015 TITLE: Nuclear Weapons System and WMD Demilitarization Safety Assessments/Special Studies

KEY TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Improved safety of US nuclear weapons systems and WMD demilitarization operations.

DESCRIPTION: Quantifying, reducing, and managing the risks associated with the life-cycle management of military nuclear weapons systems and weapon demilitarization is of vital importance. New and innovative concepts to improve on traditional probabilistic risk assessment techniques and methodologies, as well as operations are desired to increase the overall safety of these assets. Abnormal environments that these systems may encounter include mechanical insults (e.g., drops, vehicle accidents), thermal insults (e.g., fuel fires), electrical insults (e.g., lightning, electrical power), and combinations of these environments. Long range program thrusts include characterizing these abnormal environments, analyzing human factors and developing quick running models to allow decision makers to manage safety risks. Concepts should employ innovative ideas and make use of new and emerging technologies. Work will include measuring risk improvements, risk reduction techniques, and advanced algorithms for improved quick-look capabilities.Measures to improve the safety of nuclear weapons systems and demilitarization operations against all possible abnormal environments are required. Safety enhancement measures include prediction of the liklihood of adverse events through characterization of initiators and eliminating/mitigating such initiators. Proposals should describe how they will improve protection against known and predicted risks and should emphasize risk elimination/reduction where appropriate.

PHASE I: demonstrate the feasibiliity and potential usefulness of the proposed safety technologies/techniques.

PHASE II: fully develop the proposed technologies/techniques so they can be compared to existing techniques.

PHASE III-DUAL USE APPLICATIONS: Data and models from an activity such as this SBIR area have potential for adaptation to a variety of users. Risk is a common concept used in commercial activities as varied as finance (e.g., insurance) to transportation and other technical areas. Minimization of risk is important in many occupations, such as manufacturing. Risk models can be used in evaluating manufacturing alternatives, optimizing safety budgets and equipment, to reducing risks in the home or comparing potential alternate decisions. The quantification and understanding, as well as the reduction or elimination of risks can be used to increase the continued viability of many commercial endeavors.

REFERENCES:

1) Joint DoD/DOE Surety Plan, August 1991
2) Report of the Panel on Nuclear Weapons Safety, December 1990

DSWA 98-016 TITLE: High Speed Non-Line-of-Sight Wireless Data Transmission

KEY TECHNOLOGY: Command, Control and Communication

OBJECTIVE: Develop the capability to securely transmit large amounts of data such as video images from the point of transmission (camera, sensor, etc.) to a central point of annunciation at least one kilometer away.

DESCRIPTION: Sophisticated intrusion detection and assessment devices are often deployed in tactical environments without access to, nor is it logistically feasible to provide, hard wire transmission capability for the data generated. This constraint has severely hampered the mission of the security force to provide quality security for critical resources at temporary locations, where they are at greater risk, equivalent to the level of security provided at fixed permanent sites. Further restricting the transmission of large amounts of data is the requirement for low probability of interception of the transmission. The transmission must be secure and reliable. Our limited capability in this area adds great expense to deployments because of the high personnel costs associated with increased manpower requirements to compensate for the reduced technological capability.

PHASE I: Demonstrate the capability to transmit data rapidly over the devised medium during Phase I.

PHASE II: Insure secure data transmission and include the deployable security systems such as the Tactical Automated Security System (TASS) during Phase II. Examine parallel commercial applications for the home and business security industries.

PHASE III DUAL USE APPLICATIONS: Commercial home and business alarm systems.

DSWA 98-017 TITLE: Conventional Weapons

OBJECTIVE: Develop a capability to detect explosives in large containers, preferably without having to make contact with the container.

DESCRIPTION: Senior level concern for the protection of personnel and resources from the threat and acts of terrorist attacks where large amounts of explosives are employed to destroy facilities and to maim or kill personnel has prompted the call for the immediate procurement of a mobile explosive detection capability that is man portable and reasonably priced. The choice method for perpetrating terrorist acts is through the use of bulk explosives which are normally placed in large containers such as trucks, shipping containers, etc., and detonated on or near DoD installations. The logistics of detecting explosives in a large container are often employed at the expense of operational mission accomplishments and inhibits effective mission completion. While detection without contact is the ultimate goal, limited contact is acceptable under circumstances such as when explosive contraband may be hidden, obscured, or combined with a valid shipment.

Develop a prototype in Phase I and deploy for operational testing and evaluation in Phase II. If successful, initiate immediate production after OT&E and TOA for the protection of DoD personnel deployed in high terrorist threat areas.

PHASE III DUAL USE APPLICATIONS: High level Executive Protection; Municipal Infrastructure Protection and Support.

DSWA 98-018 TITLE: Detection of Minute Intrusion

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop a capability to detect small penetration of controlled spaces.

DESCRIPTION: It is widely stated that listening and video devices are now being constructed on a scale which permits discreet introduction in areas which are protected by intrusion detection devices. These devices are said to be small enough to be inserted into a secure area via a point of intrusion smaller than 1/8". Their size permits minimal signature and are difficult to detect, or assess if detected.

Phase I will seek to demonstrate the reliability of detection of miniature surveillance devices, and Phase II will incorporate the developed technology into intrusion detection systems of secure facilities where COMSEC and OPSEC are of paramount concern.

PHASE III DUAL USE APPLICATIONS: Private Investigation; Protection from industrial and economic espionage.

DSWA 98-019 TITLE: Multi-Source Data Fusion for Monitoring to Detect Nuclear Tests

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Prototype innovative techniques for detecting and characterizing patterns of interest across large, heterogeneous databases to improve the capability to monitor for violations of the Comprehensive Nuclear Test Ban Treaty.

DESCRIPTION: The impending completion of the Comprehensive Nuclear Test Ban Treaty (CTBT) has focused attention on the technical challenges of monitoring to detect evasively conducted nuclear tests, and discriminating between such tests and other events, such as earthquakes or mining activities. Monitoring the CTBT, which prohibits testing in all environments, will require the acquisition, management, fusion, interpretation, and presentation of data from heterogeneous sources and of heterogeneous types. The resulting databases will include the following classes of data: time and space series, imagery, text and speech, and more complex types (e.g., video, analog data, etc.). DSWA seeks prototype system to support robust data fusion, including the detection and characterization of interesting temporal and spatial patterns across these data classes. The prototype should focus initially on the four components of the International Monitoring System (i.e., seismic, hydroacoustic, infrasound, and radionuclide monitoring) and be extensible to broader databases, including satellite imagery, EMP, HUMINT, etc. The prototype should operate initially within, and take advantage of, the systems infrastructure of the prototype International Data Center (IDC) being developed by the Nuclear Treaty Program Office, and be extensible to final IDC in Vienna, Austria. Techniques in the related areas of data fusion, knowledge discovery, database mining, and data visualization should be considered. Prototypes that demonstrate automated and/or interactive (human driven or assisted) data fusion and decision support are of interest.

PHASE III - DUAL USE APPLICATION: Data fusion techniques to support areas involving high volumes of disparate data, e.g., the airline, mining, or medical industries. A potential military application would be for battlespace management.

DSWA 98-020 TITLE: Tracking Atmospheric Plumes Based on Stand-Off Sensor Data

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop an approach to identifying and locating the source of nuclear events that generate atmospheric plumes by backtracking their atmospheric plumes.

DESCRIPTION: An essential element of the International Monitoring System (IMS), being established to monitor compliance as part of implementing the Comprehensive Nuclear Test Ban Treaty (CTBT), is the radionuclide subsystem. The collection component of the stations of the subsystem will continuously sample the atmosphere. Periodically (e.g., every six hours) a sample will be completed and analyzed by the radionuclide detectors and their supporting systems. The results of the analysis will be transmitted to regional and/or national data centers, and/or on to the International Data Center (IDC). Analysts and/or their support systems need to be able to determine the source of those samples of interest; i.e., those that contain either certain radioactive products and/or abnormally high levels of other radioactive products. The source includes the identification and location of the nuclear-related activity that produced the radionuclide(s).

This research initiative seeks solutions (or contributions there to) to determining the likely location of the source with an immediate accuracy of within an area as small as 1,000 sq. kms (ultimately perhaps as small as .5 kms by .5 kms).

Solutions should incorporate those characteristics related to nuclear materials/products (e.g., their weight, fractionation, and recombinant potential) and the parameters associated with weather and/or climate (e.g., velocity and direction of wind currents, temperature gradients and rain) that appear to control or influence the transport and disbursement of nuclear materials/products.

It is anticipated that solutions will leverage past work on fallout and atmospheric modeling. Fallout analysis and prediction work, particularly that done during the period when atmospheric nuclear tests were allowed (approximately 1946 to 1962) and perhaps additional work related to leaks during underground testing as well as from such unfortunate events as the Three Mile Island (in Pennsylvania, USA) and Chernobyl Russia) accidents, should be considered. Atmospheric transport models should be identified and reviewed to see what factors they use as inputs and how up to date they appear to be, etc.

Solutions may automate the integration of meteorological and climatological data with quantitative data from stand-off sensors (biological, chemical, nuclear, etc.) to rapidly detect hazardous material plumes, characterize plume morphology, backtrack to the plume's source, and predict future plume propagation.

An added dimension will be determining the availability of historical data as well as current data collection activities, particularly as related to monitoring areas of interest to the United States.

PHASE III - DUAL USE APPLICATION: Environmental monitoring, including power generation plants (both nuclear and non-nuclear) and weather, and air travel safety.

DSWA 97-021 TITLE: Multi-Dimensional Visualization of Data to Identify Seismic Events or for Other Complex, Multi-Dimensional Data Problems

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop a visualization subsystem for the discrimination of different types of detected seismic events; test the subsystem with the Nuclear Treaty Programs Office's (NTPO's) Intelligent Monitoring System; and demonstrate the subsystem's potential application to other multi-dimensional data problems.

DESCRIPTION: NTPO is developing a global system for monitoring nuclear proliferation activities and for potential use in verifying compliance with a Comprehensive Nuclear Test Ban Treaty (CTBT). The system will collect data from a worldwide network of seismic stations and arrays, as well as sensors deployed for air, particulate, and other types of environmental sampling. The seismic system alone will have to process data from several hundred monitoring stations for tens of thousands of detected earthquakes and explosions per year. Results of the final analysis must be available within 24-48 hours of the occurrence of the events. Achieving this goal within the available resources will require automatic data processing and an enhanced data interpretation capability. NTPO is exploring technologies such as machine learning, machine discovery, and visualization methods to aid in the data interpretation.

This initiative seeks subsystems implementing novel visualization techniques and components to aid in interpreting the results of multivariate seismic discrimination analysis, particularly for small seismic events detected at regional distances out to 2,000 km. The subsystems will be installed in the Intelligent Monitoring System at NTPO's Center or Monitoring Research (CMR) located in Rosslyn, Virginia, and tested with data acquired and processed by the Intelligent Monitoring System. The performer will demonstrate how the visualization techniques can be applied to the general problem of monitoring the proliferation of weapons of mass destruction by demonstrating that it is capable of aiding human analysts in interpreting data from the global seismic monitoring system. The performer will also demonstrate how the techniques can be used to solve other

PHASE III - DUAL USE APPLICATION: Visualization subsystem to aid in the solution of generic multi-dimensional or multivariate problems. This could include topics ranging from environmental monitoring to air traffic control.

DSWA 98-022 TITLE: Nuclear Weapon Effects Phenomenology

TECHNOLOGY AREA: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative algorithms to improve our understanding of nuclear weapon effects and the implementation of these algorithms

DESCRIPTION: To improve the understanding of the impact of nuclear weapons under battlefield conditions, we require more accurate, efficient, user-friendly methods of calculating and displaying the affects of nuclear scenarios and their operational impact. Areas of interest include: improved accuracy even as calculational times are minimized: reliance on basic physical principles validated by measured test results: faster running calculations; and new improved ways to enable users (be they advanced nuclear weapons effects researchers, weapon systems developers, or managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects and their system impacts. Nuclear weapon effects include airblast, ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; and dust cloud formation.

Improved methods are required for the management of technical information that relates to archival of nuclear weapon phenomenology and test data as well as input to and retrieval of such data archives. Methods for developing unifying test data standards devised with application beyond just nuclear test effects are needed to improve data processing efficiency and reduced hardware and software specific requirements.

PHASE I: the research will demonstrate the feasibility of the proposed approach to improve the understanding of nuclear weapon effects or the archival and ease of use of stored data.

PHASE II: the research concepts developed in Phase I will be further developed and incorporated into appropriate codes.

COMMERCIAL POTENTIAL: Computer codes related to earthquake effects, pollution transport, signal propagation, data archival, and test standards for data.

REFERENCES:
(1) DNA EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons

DSWA 98-023 TITLE: Nuclear Collateral Effects

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Demonstrate innovative applications of advanced theoretical and numerical technologies for nuclear source terms, transport and doses.

DESCRIPTION: Of interest to DSWA is the development and demonstration of capabilities to predict nuclear hazards from facilities and weapons. These hazards must cover accident, incident and military action. New methodologies on how to create numerically efficient source terms, transport them atmospherically or by water, and effectively predict doses to different populations.

PHASE I: the research will develop concept feasibility for application in DSWA's Hazard Prediction and Analysis Capability (HPAC) software, through either analysis or laboratory demonstration.

PHASE II: the concepts will be further developed for application in DSWA's Hazard Prediction and Analysis Capability (HPAC) software.

PHASE III-DUAL USE APPLICATION: Nuclear Hazard Source, Nuclear Transport and Nuclear Dose Modeling

DSWA 98-024 TITLE: Advanced Lethality Technologies

KEY TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: Demonstrate innovative applications of advanced non-nuclear technologies for enhanced target lethality or nuclear effects simulations

DESCRIPTION: Of interest to DSWA is the development and demonstration of capabilities which may significantly extend weapons range-to-effect or enhance lethality against hard targets. The response of a hardened bunker complex or of intrinsically hard ballistic missile sub-munitions warhead payloads are of particular interest. Novel applications of explosives technology, hyperkinetic technologies concepts will be of interest.

PHASE I: the research will develop concept feasibility through either analysis or laboratory scale demonstration.

PHASE II: the concepts will be further developed through more definitive experiments and/or sophisticated computational analyses.

PHASE III: Dual use applications technologies demonstrated in this SBIR may be applicable to commercial application such as mining, where advanced explosives, increase yield, oil drilling for stemming wells, Other hyperkinetic applications apply to space craft shields.

DSWA98-025 TITLE: Structure Design Software Tools

KEY TECHNOLOGY AREA: Exploratory Development, Modeling & Simulation

OBJECTIVE: Develop software tools and translators to automatically redesign existing CAD structures based on specified hardness, building code requirements.

DESCRIPTION: The Defense Special Weapons Agency supports DoD warfighting capabilities through modeling and simulation of weapons effects, target responses, and propagation of collateral effects. Modeling and simulation tools developed for warfighting also support distributed simulation systems which provide realistic, real time simulations for training and evaluation. Tools that are

incorporated into distributed simulation systems must meet DoD mandated High Level Architecture compliance.

DSWA supports the development of simulation targets (tunnels, "cut & cover" structures, deep underground targets, and the like) using state-of-art CAD software tools. Targets are designed with a degree of detail determined by the weapons likely to be encountered and the failure modes likely to be invoked by the postulated weapons. DSWA seeks to develop automated software tools and translators that can automatically transform existing CAD designs to meet new specifications for structural hardness, design-cod specification changes, or other high level specification changes. These tools will maintain HLA compliance for translated targets used in distributed simulation architectures.

PHASE I: The Phase I effort will explore the feasibility of automating target translation. Prototype translators will be developed which will demonstrate the automated capability for selected targets of DoD interest.

PHASE II: The Phase II effort will expand the capabilities and understanding developed in Phase I and will accomplish HLA compliance for incorporation of translators in the distributed simulation environment.

PHASE III-DUAL USE APPLICATION: Software tools to assist in the evaluation of the risk of financial loss through widespread earthquake damage, to evaluate the cost effectiveness of building code adjustments, retrofits in pre-existing structures, planning and zoning design support, insurance actuarial support, civilian government planning and crisis support.

DSWA98-026 TITLE: Enhance Imaging/Search Modeling & Simulation Technology

KEY TECHNOLOGY AREA: Exploratory Development, Modeling & Simulation

OBJECTIVE: Develop new technologies through merging of oil exploration software, generic algorithm techniques, and sensor technologies as tolls for identifying underground structures of DoD interest and potential material and structure failure modes.

DESCRIPTION: The Defense Special Weapons Agency is interested in developing modeling and simulation tools that can be used to identify the existence and character of underground structures, the potential structural failure modes of both above-ground and underground targets, the prediction of failure produced by in and out of target explosives releases, and tools that can assist in the visualization of these structures. Modern software engineering techniques have been merged with advanced earth science to develop applications enabling intelligent, high resolution and physically constrained imaging of static and dynamic geological processes. DSWA has been conducting RDT&E related to generic algorithm (GA) techniques to improve modeling, algorithm development, and overall modeling and simulation capabilities. The GA technique provides an innovative approach to solving complex search and optimization problems; it offers characteristics which make it conductive to machine learning methods. the marriage of GA techniques with geological modeling and simulation promises to provide effective tools to support the DoD mission of identifying and characterizing underground targets.

PHASE I: The Phase I effort will be devoted to the incorporation of generic algorithm techniques and geological modeling and simulation capabilities in order to demonstrate the efficacy of such tools for identifying and characterizing underground targets. These may include tunnels, "cut & cover" targets, and deep, underground targets.

PHASE II: The Phase II effort will select and adopt selected remote sensor performance models and algorithms and incorporate these into tools developed under Phase I. The objective of this effort will be to demonstrate how target identification and characterization can be automated for DoD applications.

PHASE III-DUAL USE APPLICATION: Oil exploration enhancement, structural failure analysis, earthquake resistance assessment, visualization technologies enhancement.

DSWA 98-027 TITLE: Low Frequency Magnetic Signatures for Detecting & Discriminating Nuclear/non-nuclear Underground Tests

KEY TECHNOLOGY AREA: Sensors Technology/ Simulation & Modeling

OBJECTIVE: Develop physics models and computer algorithms to generate a comprehensive catalog of low frequency magnetic signal signatures arising from a finite set of known and /or possible underground nuclear and non-nuclear test (UGT) devices. In conjunction with conventional seismic techniques, use these signatures to correlate and characterize the test device to discriminate between nuclear and non-nuclear UGT events.

DESCRIPTION: Underground nuclear testing provides an effective means for concealment of clandestine nuclear weapons development programs. In particular, with proper tamping and cavity construction of volume much larger than the weapon size,

seismic signals can be masked or sufficiently distorted to preclude positive identification of a nuclear test through standard seismic identification techniques. This problem has emerged from the so-called evasion technology. Moreover, low-yield nuclear tests can be seismically indistinguishable from similar sized (non-nuclear) high explosive (HE) detonations. HE detonations are very common in the operation of existing mines and oil wells. They are also needed for the exploration of new mineral deposits and oil belts. At the present time, there is no reliable method in the national technical means (NTM) to verify if an UGT explosion is conducted for an economic development program or for a weapon development program in violation of the international comprehensive test ban treaty (CTBT). Any such UGTs are subject to challenges by the internatnal CTBT team.

An alternate but complementary method for detection and discrimination of nuclear vs. non-nuclear underground detonations is clearly needed. A promising candidate is the very low frequency (VLF) magnetic signal which is produced as a characteristic signature of an underground non-nuclear or nuclear test. The waveforms of the magnetic signal emitted in these two types of UGTs have very distinct characteristics. These waveforms can be computed by modeling the physics of signal generation for these two types of UGTs and propagation of the signal from the source to the earth surface. For nuclear UGTs the magnetic signal has been detected at a distance up to 10 kilometers from the test site [Ref. 1]. This signal can provide not only an accurate fiducial time marker of the event, but, with a proper accounting for local earth electrical conductivities and geological anomalies, can also yield information on the device size, burst location, and depth, even in situations where evasion techniques have been employed to mask seismic signal detection and characterization of the event. Moreover, in conjunction with seismic detection techniques, discrimination between nuclear and non-nuclear events should be possible. Recent advances in nano-Tesla and sub-nano-Tesla magnetic signal detection and processing techniques would permit cooperative (or covert) interrogation of identified (or suspected) nuclear test sites. However, to properly interpret these signals, a library of magnetic signal signatures for a variety of burst parameters at locations in question is required.

The signal interpretation is expected to be very difficult due to the uncertain nature of the source, the expected low level of the detected signal strength, and the presence of background natural or man-made noise and clutter. However, by comparison of the measured signal with those of the library and the use of matched filtering and other signal processing technique, an accurate assessment of the device type, yield, and other parameters could be made. Moreover, such a library would also provide information on optimum sensor placement strategy and optimization of magnetic sensor/detector hardware and software. Although qualitative estimates allow order-of-magnitude determination of signal strength and timings, quantitative information on the size, depth, location, and type of detonation can only be provided by detailed analysis and calculation of the generation and propagation of these low frequency magnetic signals to the earth surface at the sensor site. Variations and structuring in deep earth electrical conductivity significantly complicate this problem and most likely will require development of sophisticated computational techniques to accurately predict the low frequency magnetic signal propagation and diffusion through the very complex and possibly highly structured deep earth electrical conductivity. Particular attention must be paid to development of 3-D differencing algorithms or other approaches which are unconditionally stable even for significant spatial variations in earth electrical conductivity and, at the same time, are able to accurately provide (signatures) data on time scales which span from sub-microseconds to several tens of seconds or longer.

PHASE I: Select a promising approach for the accurate calculation of low frequency magnetic signals generated by underground nuclear and HE tests; carry out the preliminary development and implementation of the procedure; and demonstrate the stability, accuracy, and reliability of this approach for a variety of complex sample earth conductivity geometries (including land-ocean interfaces).

PHASE II: Finalize the approach developed under Phase I and initiate the creation of a comprehensive library of magnetic signal signatures for both nuclear and non-nuclear bursts of differing yields and depths for a minimum of three sites designated by DoD.

PHASE III DUAL USE APPLICATIONS: The procedure developed for determining the propagation of low frequency magnetic signals through realistic deep earth conductivities will be directly applicable to the problem of accurate assessment of nuclear high-altitude electromagnetic pulse (HEMP/ E3) environments, where currently, for want of a better approach, a standard uniform conductivity of 10-3 mho/m is assumed. There is a pressing need for a more accurate methodology, since in cases where nuclear HEMP/E3 environments have been calculated using experimentally measured earth electrical conductivity data, deviations by factors of 2-10 from the standard uniform conductivity model have been shown. Addressing this uncertainty will improve the assessment and mitigation of the effects of E3, and natural geomagnetic storms on long haul communacations and commercial power lines. Moreover, these same capabilities should be applicable to the commercial problems of geophysical surveying and exploration of the subsurface geological structure for minerals, oil, or natural gas, where VLF magnetic data is acquired and analyzed for prospecting. The use of natural or man-made longwave (ELF/VLF) signal probe technique is already established, but the signal data interpretation/analysis is very difficult and would be greatly improved by the development of a geology dependent signature library. New, advanced signal processing techniques could also be developed and exploited in this commercial area.

REFERENCES: J. Sweeney, "An Investigation of the Usefulness of Extremely Low-Frequency Electromagnetic Measurements for Treaty Verification", LLNL Report No. UCRL-53899, 1989. (UNCLASSIFIED)

DSWA 98-028 TITLE: Nuclear Weapon Effects Phenomenology

KEY TECHNOLOGY AREA: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative algorithms to improve our understanding of nuclear weapon effects and the implementation of these algorithms

DESCRIPTION: To improve the understanding of the impact of nuclear weapons under battlefield conditions, we require more accurate, efficient, user-friendly methods of calculating and displaying the affects of nuclear scenarios and their operational impact. Areas of interest include: improved accuracy even as calculational times are minimized: reliance on basic physical principles validated by measured test results: faster running calculations; and new improved ways to enable users (be they advanced nuclear weapons effects researchers, weapon systems developers, or managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects and their system impacts. Nuclear weapon effects include airblast, ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; and dust cloud formation.

Improved methods are required for the management of technical information that relates to archival of nuclear weapon phenomenology and test data as well as input to and retrieval of such data archives. Methods for developing unifying test data standards devised with application beyond just nuclear test effects are needed to improve data processing efficiency and reduced hardware and software specific requirements.

PHASE I: the research will demonstrate the feasibility of the proposed approach to improve the understanding of nuclear weapon effects or the archival and ease of use of stored data.

PHASE II: the research concepts developed in Phase I will be further developed and incorporated into appropriate codes.

PHASE III DUAL USE APPLICATION: Computer codes related to earthquake effects, pollution transport, signal propagation, data archival, and test standards for data.

REFERENCES:
(1) DNA EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons

DSWA 98-029 TITLE: Human Response Models for Performance and Risk Estimation

KEY TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Investigate and identify methods to represent human behaviors (performance and risk) after exposures to nuclear, biological, chemical and/or radiological environments.

DESCRIPTION: Recent emphasis changes on casualty and risk priorites necessitate the creation of models to describe effects on humans for military and civilian populations from weapons of mass destruction not previously represented. This includes population demographics other than healthy, feeling fine military; secondary and tertiary blast; cognitive effects, and connection of risk to performance-based standards.

PHASE I: Identify promising methodologies/applications to represent human behavior, cognitive, performance and/or health risk to military and civil populations after exposure to the effects of weapons of mass destruction.

PHASE II: Implement the identified methodology(ies)/application(s) to create a model(s) to fill the void. Conduct verification & validation experiments. Connect to existing DSWA human response models that provide the basis for US doctrine.

PHASE III DUAL USE APPLICATIONS: Human response models that address a broad demographic range will be useful to any emergency response manager for applications to explosions, and to accidental or intentional releases of NBC material. There is a very high likelihood for joint funding from FEMA in Phase III.

REFERENCES:
DSWA EM-1, Effects of Nuclear Weapons on Personnel, Chapter 14.
Glasstone, The Effects of Nuclear Weapons

BALLISTIC MISSILE DEFENSE ORGANIZATION (BMDO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals - Instructions

Send Phase I proposal packages (the unbound original, to make extra copies, and six bound copies, to immediately forward to evaluators, of the full proposal, **PLUS** one additional copy of Appendices A and B only) by US mail (or any commercial delivery service). Also, APPENDIX E needs only to be with the unbound original. **DO NOT** attach APENDIX E to the six bound copies. The mailing address follows and the BMDO SBIR website address is provided.

Ballistic Missile Defense Organization
ATTN: TOI/SBIR (BOND)
1725 Jefferson Davis Highway, Suite 809
Arlington, VA 22202

For Administrative HELP ONLY call: **800-937-3150** or **800-WIN-BMDO**
Internet Access: **www.futron.com/bmdo/sbir.html**

Proposals delivered by other means will not be accepted. Proposals received after the closing date will not be processed. BMDO will acknowledge receipt of proposals IF AND ONLY IF the proposal includes a self-addressed stamped envelope and a form that needs only a signature by BMDO.

All proposal submission appendices may be downloaded from the DoD SBIR Website at (http://www.acq.osd.mil/sadbu/sbir/appendcs.htm). Furthermore, all companies are strongly encouraged to upload their APPENDIX A and APPENDIX B only, through the BMDO SBIR Website at (http://www.futron.com/bmdo/sbir.html). Uploading the two appendices will allow BMDO to process proposals faster so that evaluations can be received quickly. It is in the companies best interest to upload their APPENDIX A and APPENDIX B since those proposals will be processed first.

The intent of BMDO, first and foremost, is to seek out the most innovative technology that might enable a defense against a missile in flight -- lighter, faster, stronger, more reliable technologies are all of interest. Proposers need not know specific details of possible BMDO systems, research and development goals, or specific technology needs or requirements, but must understand that potential technologies should have application to ballistic missile defense at some level. (A better fire extinguisher, although it may be innovative and there is a commercial market, does not support ballistic missile defense requirements at any level.)

Specifically, **BMDO seeks to invest seed-capital, which supplements private sector investment support, in a product with a future market potential (preferably private sector) and a measurable BMDO benefit.** BMDO SBIR will not support or further develop concepts **already mature enough to compete** for private capital or for mainline government research and development funds. Phase I proposals should focus on the innovation of the proposed technology, it should illustrate the concept feasibility, and the merit of a Phase II for a prototype or at the very least a proof-of-concept. Phase II competition will also be judged intensely on future market possibilities and commercialization potential. Phase II proposals may be submitted anytime after the Phase I begins. Unique efforts showing time sensitivity or submitted for *FasTrack* will be given due consideration for Phase II start-up funding and Phase I proposals may include a post-Phase I optional tasking that will permit rapid start-up if the Phase II or *FasTrack* application is approved. BMDO is currently developing its own *FasTrack* procedures, incorporating the central principles of the Fast Track policy (Section 4.5), subject to approval by the Under Secretary of Defense for Acquisition and Technology this fall. Once approved, the BMDO procedure may be found at the website address under the Frequently Asked Questions (FAQs) section.

Principal Investigators who are tenured faculty are **NOT** considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract; any waiver must be requested explicitly with a justification showing a compelling rational and national need; BMDO expects to grant no waivers.

BMDO intends for a Phase I to be only an examination of the merit of the concept or technology with an average cost under $65,000. Although proposed cost will not affect selection for negotiation, contracting may be delayed if BMDO reduces the proposed cost. **DO NOT** submit the same proposal, or variations thereof, to more than one BMDO topic area; each idea will be judged once in an open competition among all proposals. Furthermore, BMDO performs numerous cross-reference checks within each solicitation.

Because BMDO seeks the best nation-wide experts in innovative technology, proposers may suggest technical government reviewers by enclosing a cover letter with the name, organization, address, phone number, and rationale for each suggestion. BMDO promises only to consider the suggestion and reserves the right to solicit other evaluations.

BALLISTIC MISSILE DEFENSE ORGANIZATION TOPICS

BMDO FY98 TOPIC DESCRIPTIONS

BMDO 98-001 Directed Energy Concepts and Components

BMDO seeks innovative and applied research toward advanced technology developments in the generation, propagation, and detection of directed energy in all forms. Dual-use systems under consideration include, but are not limited to, solid-state lasers (i.e.diode lasers), chemical lasers, excimer lasers, IR/Vis/UV lasers, x-ray lasers, gamma-ray lasers, free electron lasers, quantum lasers, particle beams, radio-frequency (RF) and millimeter wave (MMW), and other unique hybrid approaches. Furthermore, any component or subcomponent that is utilized by any of these systems is of interest. Included herein are such topics as beam control, target acquisition, tracking and pointing, mirrors, beam propagation and steering, optics, conversion methods, countermeasures and coatings, micro-optical devices incorporating these aspects.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company A whose advanced x-ray source is being utilized for waste sterilization was sponsored from this topic. Company B utilized their tunable filters with the citrus industry and for military hyperspectral image applications.

DoD Key Technology Areas: Electronic Warfare/Directed Energy Weapons, Electronics

BMDO 98-002 Kinetic Energy Kill Vehicles and Components

Kinetic energy (KE) weapons candidates presently include a variety of ground and space based interceptor concepts including their propulsion sub-system components. System elements include ground-based launchers, axial and divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: finding the booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C.G. Control algorithms, fast frame multicolor and ultra-violet Seekers, acquisition and track; target discrimination, seeker operational environments, lethality/miss distance; aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermal-structural integrity, non-nuclear kill warhead performance, target acquisition in a hostile environment, performance and survivability of electronics in a hostile environment; firing rate, projectile guidance and control and projectile launch survivability; and, common among all systems reliability, producibility, safety (non-hazardous operation), maintainability, and low cost/low mass; aeroshell ablation control; electromagnetic launches.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company C advanced the metal armature developments for military railgun efforts. Company D began with a bone implantation technology and international investments that resulted from divert motor rocket nozzles. Company E, with a market cap of $20M+, expanded with technology genesis to a dynamic frame seeker and chip-stacking developments. Company F, with a market cap of $240M+, supported ballistic missile defense efforts with their enhanced lethality kinetic energy projectile.

DoD Key Technology Areas: Air Vehicles/Space Vehicles, Conventional Weapons

BMDO 98-003 Sensors

Sensors and their associated systems/sub-systems will function as the "eyes and ears" for ballistic missile defense applications, providing early warning of attack, target detection/classification/identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional and innovative techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from backgrounds, debris, decoys and other penetration aids are specifically sought. Sensor-related device technology is also needed. Examples of some of the technology specific areas are: cryogenic coolers (open and closed systems), cryogenic heat transfer, superconducting focal plane detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long-wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities), interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based ballistic missile defense applications (uv-sub-mm wave), new optics and optical materials. Entirely new and high-risk approaches are also sought. Please indicate the particular subtopic identifying letter your specific proposal/technology addresses:

BMDO98-003**A** - Acoustic and Seismic
BMDO98-003**B** - Radar and MMW
BMDO98-003**C** - UV (<0.3 microns)
BMDO98-003**D** - Visible (0.3 - 0.9 microns)
BMDO98-003**E** - IR (>0.9 microns)
BMDO98-003**F** - Gamma/X-Ray
BMDO98-003**G** - Other

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company G, with commercial sales of $15M+, is noted for its laser diode pumped q-switched solid state laser products. Company H, with a market cap of $24M+, transferred its microwave based infrared detector and superconducting millimeter wave mixer technologies for a variety of cryogenic systems and products. Company I's high power laser array transmitters are utilized on future military satellites for communications.

DoD Key Technology Areas: Sensors, Electronics

BMDO 98-004 Unit Cost Reduction (unavailable in FY98)

BMDO anticpates no technology requirements under this topic for this year.

BMDO 98-005 Non-Nuclear Power Sources and Power Conditioning

New technologies for providing power which provide substantial improvements in lower recurring cost, lower mass, and/or smaller size are sought for all ballistic missile defense applications. New concepts for power sources and power conditioning devices for transportable or mobile systems at 200 kW to 1 MW also need to have high efficiency, low signatures, and high reliability. Power generation and power conditioning devices that operate at cryogenic temperatures for use in a new concept for all cryogenic systems are sought. Power conditioning devices of interest include, but are not limited to, capacitors, inductors, and switches. Space assets' power sources in the 0.5 to 5 kW power range, including solar arrays and their photovoltaic cells, need to tolerate high natural radiation levels. Satellite energy storage systems or novel battery technologies must provide cycle lifetimes of up to 40,000 cycles and may be utilized in low earth orbit sensor satellites. Onboard power sources for interceptor missiles need to be periodically testable and have a quick start-up capability. Power conditioning systems and components for space assets should provide very high efficiency.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company K, with a market cap of $48M+, has provided for commercializing its self-restoring fault current limiter after it was incorporated into military efforts.

DoD Key Technology Areas: Aerospace Propulsion and Power

BMDO 98-006 Propulsion and Logistics Systems

In general, missile defense places unprecedented demands on all types of propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. Specifically, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in desired locations. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g. extending storage time of cryogenic fluids (e.g. H_2 and Xe), reduction of contamination from effluents, and sensors and controls for autonomous operation. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of solar power demonstration missions incorporating electric thrusters, BMDO seeks high power electric thruster modules (e.g., electrodes, insulators, ignition systems, propellant controls, command and control systems, thermal management systems, and power conditioning units). With the advent of small surveillance satellites, low power (0.5 to 2 kW) electric propulsion is under consideration for station keeping and orbit transfer; for such systems emphasis is being placed on achieving higher power densities for components of the integrated system (thruster, power conditioning unit, fuel control, gimbals, and fuel storage). Low mass or miniature interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid).

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company L, with a market cap of $25M+, developed a laser radar tracking technology that finds commercial use in laser eye-surgery applications, but was also investigated for tracking ballistic missiles in flight.

DoD Key Technology Areas: Aerospace Propulsion and Power, Air Vehicles/Space Vehicles

BMDO 98-007 Thermal Management

Higher power levels of various ballistic missile defense assets must dissipate heat at state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for power generation systems, space platform payloads, and all associated electronics. Some space platforms will require years of storage of large amounts of cryogen with minimum cryogenic loss and high cryogen delivery rates under condition of zero-g. Concepts, devices, and advanced technologies for all types of space-based power cycles are sought which can satisfy these projected ground/air/space platform requirements.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Currently addressing electric vehicle technology applications for military and commercial interest, Company M got its initial start, and now with a market cap of $75M+, with active magnetic vibration isolation controls funded under this topic.

DoD Key Technology Areas: Electronics, Air Vehicles/Space Vehicles

BMDO 98-008 Survivability Technology

Missile defense elements must operate and survive against determined attacks. Threat actions can generate a reasonable set of hostile man-made environments before and during operations. Collateral environments and natural space environments (atomic oxygen, space radiation and micrometeorites/debris) provide additional technical challenges which also affect civilian assets. Survivability engineering technology and survivablility enhancement options are required to achieve a cost-effective, yet integrated solution to a dynamic and diverse set of hostile environments with a focus toward improving aspects of threat sensing, hardening, passive defense, and camouflage, concealment and deception (CCD).

Sensor technologies enable the defense elements to detect nuclear events, laser and radio frequency weapon attacks, and to respond appropriately. Sensor technologies which can characterize the threat according to direction of attack, and spectral characteristics are currently under consideration. Technologies to enhance passive defense missile systems, ground/air/space assets, and support equipment are needed to operate against the threat support sensors, including radar, passive visible/IR sensors and seekers, and laser radar.

Passive hardening against the nuclear, laser, RF, ballistic and debris environments is specifically needed, in addition to novel hardening technologies and approaches against the natural space environments. Sensor technologies and their associated systems, communications antennas (RF and laser), attitude sensors, solar power, propulsion, structure and thermal control are all directly exposed to nuclear, laser, RF and debris in addition to the natural space environments. Materials and component designs which are intrinsically hard to these environments, and/or protective devices are needed, specifically with dual-use commercialization applications. A key ballistic missile defense area of consideration is seeker/sensor subsystems, the components of which (baffle materials, mirrors, optics, structures, focal plane arrays, read out electronics, and processing) must survive the laser, nuclear, IR, and natural environments. Nuclear and laser hard concepts, materials, and devices for protection against unknown or agile lasers and rejection of RF energy. Structures and coatings providing appropriate thermal characteristics, stability under mechanical impulses and hardness to laser and RF radiation are needed. Processors capable of operating in unique hostile environments presented by the strategic applications while retaining full functionality are desired. Long term space (commercial and government) applications are direct beneficiaries of these advanced technology developments.

Countermeasures and integration of CCD technologies are particular useful to the operational forces and, in general, attempt to incorporate the latest military and commercial technologies to ensure an effective response to any advanced threat. A new class of weapons technologies are evolving incorporating non-lethal methods. These have a broad range of applications as a survivability countermeasure or must themselves be countered to assure full operability. The non-lethal technology efforts in this area have dual-use applications with law enforcement techniques.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company N, with a market cap of $170M+, got started with its hardened electronics for military environments. Company O markets holographic products to the commercaial market that started with rugate filters for sensor protection of optics on military platforms.

DoD Key Technology Areas: Electronics, Sensors, Surface/Under Surface/Ground Vehicles

BMDO 98-009 Lethality and Vulnerability

A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed energy and/or kinetic energy devices used against responsively hardened targets, bulk powder, and submunition targets. Battlefield by-products of post-intercept events are currently under consideration. New concepts and technologies which produce a much higher probability of hit-to-kill intercepts is required to support applications. Ground and Point-of-Intercept technologies, instrumentations, concepts, and innovative methodologies are under consideration for cost effective incorporation into BMDO lethality efforts. Additionally, novel concepts and techniques which reduce the vulnerability of ballistic missile defense systems will increase the operational confidence level of dedicated assets. Commercial applications may benefit from the incorporation of the techniques utilized in cost-reduction, measurement and diagnostics, and meteorology instrumentation packages.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company P was started after receiving initial funding under this topic for its solid state optical devices, which are now commercial products.

DoD Key Technology Areas: Conventional Weapons

BMDO 98-010 Computer Architecture, Algorithms, and Models/Simulations

Missile defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of specific interest include:

- New computer architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.
- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.
- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular task (for instance, the execution of a phase retrieval algorithm for interferometric imaging) and may include neural networks.
- Language design to develop code optimized for highly parallel processed architectures.
- Testing techniques that will provide a high level of confidence in the successful operation of concurrent, real-time, distributed large-scale software systems. Examples include sensitivity analysis, data flow testing, mutation testing, static concurrency analysis, and dependency analysis.
- Computer network and communications security. R&D for trusted computer systems in accordance with DoD 5200.28.STD; integration of COMPUSEC with COMSEC (DoD 5200.5).
- Self-adaptive processing and simulation. Algorithms and architectures for advanced decision making.
- Neurocomputing and Man-Machine Interface - rule-based artificial intelligence and neural networks combined for decision making flexibility and system robustness; development of decision trees and information display for highly, automated, short response time, training adaptive high volume scenarios.
- Software architectures for embedded computer networks that especially facilitate incremental system and software integration, hardware and software maintenance, and system evolution, without significant performance degradation.
- Hardware and software self-diagnostic capabilities for monitoring the operational readiness and performance of space and ground systems incorporating embedded computer networks.
- Virtual environments to allow diverse groups to interact in real time and increasingly realistic ways over large distances which may include hostile environments definition and ground effects modeling and simulation efforts.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company Q, with commercial and military sales of its automatic parallelization tool for sequential programs, marketed as *INSURE++* and *CodeWizard for Java*, is in excess of $10M/year.

DoD Key Technology Areas: Battlespace Environments; Computing and Software; Human Systems Interface; Manpower, Personnel and Training; Modeling and Simulation

BMDO 98-011 Optical Computing and Optical Signal Processing

Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. Non-linear optical materials advancements and new bistable optical device configurations.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company R took a unique technology approach in addressing fiber-optic and other optical communications applications to both the military and commercial industry. Company S is providing a low-loss electro-optical switching array, Company T is providing optical bus extenders and fiber-optic modulators, Company U has funded technology which utilized wavelength division multiplexing techniques; all to support the ever growing optical communication industry.

DoD Key Technology Areas: Command,Control and Communications; Computing and Software; Electronics

BMDO 98-012 Structural Concepts and Components

Minimum weight structures are needed in ballistic missile defense applications to withstand high-g loading, acoustic and thermal environments of ground based interceptors, and to provide solid bases for space systems pointing and tracking. Such structures will benefit from: (1) innovative vibration control techniques, (2) innovative fabrication approaches to cut structure cost, and (3) innovative use of advanced materials and/or design approaches to minimize structure weight. For instance, techniques and experimental verification are needed for active and/or passive methods to measure and control vibrations caused by thermo-mechanical flutter, thruster firing, or structure borne noise caused by on-board mechanisms. "Active" structural elements containing materials and electronics to provide predictable mechanical displacement in response to applied electrical signals are of interest. Maximization of displacement, mechanical strength, and reliability; parameter stability over extended temperature ranges; and minimization of driving voltage, power, and weight of these elements are desired. Producibility improvements for curved actuator elements, flextensional, and other integrated motion amplifiers are of interest. Fabrication approaches that provide minimum weight with reduced assembly, inspection, and scrap rates for conventional, advanced composite, and "active" structures are needed to reduce costs. Of course, novel designs and material usage to reduce structure weight, while maintaining or increasing capability, are always desirable goals

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company V took its ultrasonic motor technology to the commercial industry and that motor can now be found in assorted novelty and gift items. Company W, with a very accurate and precise gimbal for military laser communications, also has sales to the commercial optical industry.

DoD Key Technology Areas: Material, Processes and Structures; Manufacturing Sciences and Technology

BMDO 98-013 Structural Materials and Composites

Many of the anticipated structural advances sought will depend on major improvements in materials properties and cost effectiveness. Space structures supporting seekers and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Surface launched interceptors must withstand high-g loads, aerothermal heating, and structural vibration without compromising tracking accuracy. Lightweight materials are very beneficial for both ground and space based systems. Specific goals require advanced techniques and processes that include imparting oxidation resistance and damage tolerance to composites and creating high elastic modulus composites for use over a broad range of temperatures. The following are specifically sought: (1) innovative manufacturing methods for producing high modulus, fiber-reinforced glass, light metal (i.e. aluminum or magnesium), or resin matrix composites; (2) innovative procedures for the production of instrumentation, sensors, and software for on-line process monitoring and evaluation of high modulus, fiber-reinforced composites during fabrication; (3) novel approaches to tailor fiber/matrix interfaces to maximize capability in advanced composites; (4) novel methods to cut fabrication cost of metallic and/or composite spacecraft and interceptor structures; (5) innovative tooling techniques for near-net shape production of advanced composites; (6) novel low-to-no outgassing joining/bonding techniques for advanced composites; (7) innovative surface modifications to promote wear resistance; (8) new methods for integrating instrumentation (e.g., embedded sensors) into advanced composite materials and structures; and (9) novel instrumentation for determination and telemetry of material properties and data from space. Advances are also sought in materials for optical system components, mechanical moving assemblies, and protective coatings.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company X has commercial sales of $16M+ for its solid lubricants for space structures for both military and civilian applications.

DoD Key Technology Areas:Materials, Process and Structures; Manufacturing Sciences and Technology

BMDO 98-014 Electronic Materials

The necessary advances in electronics for the many ballistic missile defense applications will require advances in electronics materials. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/superlattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with unique electronic characteristics. In addition, exploitation of the unusual electronic properties of gallium nitride is of considerable interest. Among the many BMDO electronic needs and interest are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, single-electron transitors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company Y, with a market cap of $210M+, commercialized technology that allowed for the delivery of ultra-pure materials to semiconductor thin film reactors. Company Z, with a market cap of $14M+, manufactures radiation detection devices and was funded for avalanche photodiode arrays. Company AA, with a market cap of $97M+, has a substantial market share of the atomic layer epitaxy growth method of semiconductor compound materials based on efforts funded under this topic. Company BB, with a market cap of $155M+, which manufactures flat panel display devices, received some initial funding for their silicon-on-insulator films and organometallic chemical vapor deposition technology developments. Company CC, with a market cap of $200M+, commercialized technology based on degradation resistant laser diodes. Company DD, with a market cap of $14M+, is in the process of commercializing technology based on its surge suppression devices. Company EE, with a market cap of $265M+, had initial funding for its high bandgap compounds and laser diode products to develop a number of commercial and military products. Company KK established a multilayer coating technology that can be easily transported to any location for application. Company FF developed a magnetoresistive non-volatile random access memory chip which is also radiation hardened and is utilized in a number of space applications for the military and commercial sectors.

DoD Key Technology Areas: AirVehicles/Space Vehicles; Electronics; Electronic Warfare/Directed Eneregy Weapons; Materials, Processes and Structures; Sensors; Surface/Under Surface/Ground Vehicles

BMDO 98-015 Superconductivity Concepts and Materials

BMDO is interested in demonstrating both high temperature superconductor (HTS) and low temperature superconductor (LTS) devices to enable or improve strategic defenses. Emphasis in HTS technology focused toward components integrated with state-of-the-art cryoelectronics for communications systems at K- and S-bands and radar systems in the X-band power and inductive energy storage are of specific ballistic missile defnese interest. The demonstration of HTS materials toward limited detection of radiation in the optical, IR, MWIR, and LWIR bands as well as for signal processing applications is also of interest. The emphasis in LTS technology is in the development and demonstration of high sensitivity detectors, digital electronics, and memory enabling on-focal plane array signal processing and operating at temperatures greater than 10K. Efforts should address packaging and interface issues and systems integration with cryocoolers and stored cryogens.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company GG, with a market cap of $45M+, fabricates optical components for industrial and military applications finds traceability back to superconducting detectors funded under this topic. Company HH, with a market cap of $43M+, demonstrated success from its technology based on multi-GHz superconducting shift registers.

DoD Key Technology Areas: Electronics; Sensors

BMDO 98-016 Surprises and Opportunities

Since ballistic missile defense is an exploration at technology's leading edge, it recognizes that surprises and opportunities may arise from creative and innovative minds. BMDO will consider proposals in other technologies where they present an unusual opportunity for ballistic missile defense applications. The proposer should take special care to describe the technology in complete detail and specify why ballistic missile defense applications would benefit from exploring its unique and novel implications. Proposers should make special note that proposals in this topic will receive preliminary screening at BMDO that may reject them as too far afield without the benefit of a full technical review received by proposals in the topics already listed. It is recommended that the proposer focuses their submission toward one of the specific outlined topics above unless the technology proposed is truly an unquestionable innovation. This full and open call is for new/novel/innovative advanced technology development, and not for the recycling of old ideas, incremental advancements, or questionable improvements.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company JJ, with a market cap of $740M+ (The largest of any BMDO SBIR recipient.), was funded for technology to further its intelligent client-server software solutions for mission-critical decision applications in real-time military and commercail environments.

DoD Key Technology Areas: Any potential new development may address a DoD Critical Technology Area from this topic, provided it supports BMDO mission interest at some level.

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Operations Command's (USSOCOM) missions include developing and acquiring unique special operations forces (SOF) equipment, material, supplies and services. Desired SOF operational characteristics for systems, equipments and supplies include: lightweight and micro-sized; reduced signature and low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extremes temperature environments; water depth and atmosphere pressure proof; transportable by aircraft, ship and submarine, and deplorable by airdrop; LLPI/LPD jam resistant C3I, electronic warfare capable of disruption and deception; near real-time surveillance, intelligence and mission planning; highly lethal and destructive; low energy/power requirements; and compatible with conventional force systems. USSOCOM is seeking small businesses with a strong research and development capability and understanding of the necessity for consideration of these SOF operational characteristics for systems. The topics on the following pages represent a portion of the problems encountered by SOF in fulfilling its mission.

USSOCOM invites the small business community to **send proposals (original plus 3 copies) directly to the following address**:

United States Special Operations Command
Attn: SOAC-KB/SBIR Program, Topic No. SOCOM 98-00__
2408 Florida Keys Avenue, 2nd Floor
MacDill Air Force Base, Florida 33621-5316

The proposals will be distributed to the appropriate technical office(s) for evaluation. **Inquires of a general nature or questions concerning the administration of the SBIR program should be addressed to :**

United States Special Operations Command
Attn: SOSB/ Ms. Karen L. Pera
7701 Tampa Point Blvd.
MacDill Air Force Base, Florida 33621-5316
Tel (813) 828-9491
Fax (813) 828-9488
E Mail perakl@hqsocom.af.mil

General/routine correspondence being dispatched by overnight delivery should use the following address:

United States Special Operations Command
ATTN: SOSB/Karen L. Pera
Building 143
2600 Pink Flamingo Avenue
MacDill AFB, Florida 33621-5316

USSOCOM has identified 4 technical topics for the FY 98.1 solicitation to be released to which small businesses may respond. The topics listed are the only topics for which proposals will be accepted. The topics were initiated by USSOCOM technical offices that manage the research and development in these areas. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

Firms are encouraged to submit a proposal for an optional task which would be performed during the period between Phase I completion and Phase II contract award. The optional task provides the opportunity to reduce the gap between Phase I and II funding. The maximum amount of SBIR funding used for an USSOCOM Phase I award is $100,000. Proposals that include the option task shall not exceed $70,000 for Phase I and $30,000 for Phase I Option. Options must be submitted with the basic Phase I proposal and will not be included in the basic Phase I proposal page limitation. The basic Phase I proposal shall be evaluated exclusive of the option task and must be proposed and priced separately. The option portion of the proposal shall not exceed 10 pages, not exceed $30,000, not exceed three months in duration, and will be evaluated using the same evaluation criteria as Phase I proposals. The transition option work shall be included as an option in the Phase I contract and evaluated for USSOCOM unilateral exercise at any time after Phase I award through the conclusion of the basic Phase I contract. Exercise of any option shall be at the sole discretion of USSOCOM and shall not obligate USSOCOM to make a Phase II award.

Evaluation Criteria - Phase I & II

1) The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.

2) The qualifications of the proposed principal/key investigators supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

3) The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in this solicitation. As funding is limited, USSOCOM reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result , USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals are deemed superior, or it may fund no proposals in a topic area.

USSOCOM also encourages contractors to participate in the SBIR Fast Track program as described in the DOD 98.1 Solicitation, para 4.5. Proposing Options in the initial proposal will not prevent a contractor from participating in the Fast Track Program, however, the total USSOCOM funds for a Phase I, options, and the Fast Track funding will not exceed $140,000. It is anticipated the vast majority of Fast Track proposals will receive interim funding between Phases I and II, and that the percentage of Phase I Fast Track projects that are selected for Phase II awards should be significantly higher that the overall percentage of Phase I projects that are selected for Phase II.

USSOCOM offers information on the Internet about its SBIR program on the SOAC Home Page at http://www.soac.hqsocom.mil

USSOCOM
FY 1998 SBIR TOPIC INDEX

SUBJECT/WORD INDEX TO THE SOCOM SBIR SOLICITATION

USSOCOM

FY 98.1 TOPIC DESCRIPTIONS

SOCOM 98-001 TITLE: Non-Invasive Blood Oxygen Sensor

KEY TECHNOLOGY AREA: Biomedical

OBJECTIVE: A non-invasive sensor for real-time continuous monitoring of blood oxygen levels for military breath-hold divers to prevent injuries

DESCRIPTION: Develop a sensor package that can be incorporated into existing diving equipment (e.g., the diving mask). Or a minimally intrusive stand-alone system (e.g., inserted into the ear or attached to the wrist). The device should alert divers to increasing levels of risk by use of warning tones, warning lights, vibrating alarms, or other appropriate means.

PHASE I: Identify medical and non-medical sensors that can be used to monitor blood oxygen levels non-invasively. Consideration must be given to the military breath-hold diver's unique operating environment, equipment, and mission profiles. Design an integrated or stand-alone packaging concept for the sensor, power supplies, any required controllers, and diver alert components. Select, obtain, and configure the most promising candidates, and conduct laboratory-scale testing to prove-out components and configuration.

PHASE II: Conduct design optimization studies, and build and field-test the resulting prototype. Prepare documentation to support transition to production.

PHASE III DUAL USE APPLICATIONS: Potential military applications of the technology, in addition to the above, include, combat casualty care in austere field environments. Commercial applications include sport diving and emergency medical care. Commercial technologies that could be inserted into defense systems as a result of this project include production process control sensors.

SOCOM 98-002 TITLE: Desktop Teleconferencing

KEY TECHNOLOGY AREA: C3

OBJECTIVE: Design an integrated engineering plan that converts existing and planned Special Operations Forces (SOF) networks to support desktop videoconferencing, distance learning, and telemedicine applications.

DESCRIPTION: Desktop videoconferencing, distance learning, and telemedicine applications are rapidly expanding with new products and technology. The distributed nature of SOF headquarters elements and deployed forces places a greater emphasis on the ability to convene and conduct long distance networking using these new technologies. To date, impediments to rapidly absorbing these new technologies have been based on interoperability, standards, and physical size of deplorable components. Special Operations Forces (SOF) requires the development of an integration architecture and phasing plan that incorporates appropriate industry standards such as H.320, T.120, H.323, and H.324 as well as iso-Ethernet and Asynchronous Transfer Mode technologies into a coherent blend that supports deployed forces with desktop video teleconferencing, distance learning and telemedicine capabilities.

PHASE I: Investigate technologies, standards, applications, and devices suitable for use in desktop teleconferencing within the SOF network environment.

PHASE II: Develop a coherent architecture and phasing plan to incorporate across SOF networks. Develop a test plan and conduct appropriate testing of recommended technologies within existing SOF integration sites.

PHASE III DUAL USE APPLICATION: The resulting design will have applications in business, education, government, and health care. Specific market segmentation opportunities will arise with respect to enhancing the bandwidth of existing networks without expanding the infrastructure; creation of virtual classrooms leveraging instructors and facilities; interactive services, animation and video compression; and medical education, consultation, administrative services and long distance control and use of special medical peripheral devices.

SOCOM 98-003 TITLE: Portable Vehicle Disturbance Detector

KEY TECHNOLOGY AREA: Surface/Under Surface/Ground Vehicles

OBJECTIVE: Develop a portable vehicle protection system

DESCRIPTION: Special Operations Forces (SOF) may be called on to operate in hostile environments all over the world. A need exists for a lightweight and rapidly deployable system that can protect vehicles used by SOF personnel during garrison and field operations from tampering. This device shall protect all vehicle locations and, once configured for a particular vehicle, have no blind spots. This system shall be capable of remote activation, and shall alert the user within range (or when he returns within range) that the plane of the vehicle outline has been broken or actual contact with the vehicle has occurred. Ideally, the alert shall also categorize the threat to the vehicle. Of concern is minimizing intentional or unintentional false alarms. A variety of technologies may be required to eliminate all potential tampering methods.

PHASE I: Identify and assess systems that can address this requirement. Obtain/develop laboratory prototype (s) and test on representative vehicles. Tests should address tampering and anti-tampering-countermeasure threats, as well as ambient false alarms associated with SOF operating environments.

PHASE II: Configure field-testable prototypes and support operational evaluation. Prepare manufacturing cost analysis.

PHASE III DUAL USE APPLICATIONS: Commercial applications include law enforcement, vehicle anti-theft, and security industries, both nation-wide and internationally.

SOCOM 98-004 TITLE: Surprises and Opportunities

KEY TECHNOLOGY AREA: Multiple

OBJECTIVE: Special Operations Forces (SOF) Vision 2020 provides the template for future SOF capabilities. To enable the capabilities of this Vision, SOF must continue to be on the leading edge of many technologies. USSOCOM recognizes that surprises and opportunities may arise to support the Vision from creative minds, and will consider proposals in technologies that present an unusual opportunity.

DESCRIPTION: USSOCOM is interested in innovative applications of advanced technology to improve existing capabilities or enable new capabilities in the following areas: air, ground and maritime mobility platforms (performance enhancements and operating cost reduction); sensors; secure communications; advanced munitions and explosives; miniaturized electronics; high density power supplies, operator and systems signature reduction; and unmanned platforms. Proposers should take special care to describe the technology application in complete detail, what makes it truly innovative, and why USSOCOM would benefit from exploring its implications. Proposers should note that proposals in this topic will receive preliminary screening that may reject them as too far afield without the benefit of a full technical review received by proposals in topics already listed.

PHASE I: Proof-of-Concept with brass-board prototypes.

PHASE II: Development of field testable prototypes and risk reduction for Phase III transition.

PHASE III DUAL USE APPLICATIONS: Will be determined for each case submitted.

OSD DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING SMALL BUSINESS INNOVATION RESEARCH PROGRAM

PROGRAM DESCRIPTION

Introduction

The Army, Navy and Air Force hereafter referred to as DoD Components acting on behalf of the Office of Technology Transition in the Office of the Director, Defense Research and Engineering, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms, with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercial the results are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results.

The DoD Program presented in this solicitation strives to encourage technology transfer with a focus on advanced development projects with a high probability of commercialization success, both in the government and private sector. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be considered. DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract.

The Fast Track provisions in section 4.0 of this solicitation apply as follows. Under the Fast Track policy, SBIR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to receive interim funding between Phases I and II, to be evaluated for Phase II under an expedited process, and to be selected for Phase II award provided they meet or exceed a threshold of "technically sufficient" and have substantially met their Phase I technical goals, as discussed in Section 4.5. Under the Fast Track Program, a company submits a Fast Track application, including statement of work and cost estimate, within 120 to 180 days of the award of a Phase I contract. Also submitted at this time is a commitment of third party funding for Phase II. Subsequently, the company must submit its Phase I Final Report and its Phase II proposal no later than 210 days after the effective date of Phase I, and must certify, within 45 days of being selected for Phase II award, that all matching funds have been transferred to the company. The company will receive phase II contract award within an average of five months from the end of Phase I.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase 11 where it is felt that the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase Ill. Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General Information questions pertaining to proposal instructions contained in this solicitation should be directed to: the point of contact identified in the topic description section of this solicitation. Proposals should be mailed to the address identified for this purpose in the topic description section. Oral communications with DoD personnel regarding the technical content of this solicitation during the Phase I proposal preparation periods are <u>prohibited</u> for reasons of competitive fairness.

OSD Deputy Director of Defense Research & Engineering

FY 1998 Topic Descriptions

ARMY, *Natick Research, Development & Engineering Center* (NATICK)

Technology Focus Area: Lightweight Warrior Systems

The dismounted soldier is central to all land operations. In order to accomplish his mission effectively he must be able to move efficiently over variable terrain. The soldier is overloaded by the weight of the items that he must carry. This weight presently approaches 200 pounds which is unacceptable as a combat load. In an effort to reduce the combat load of the soldier, the U.S. Army Natick RD&E Center has identified seven topics that focus on technology areas where improvements can be made to reduce the load carried by the soldier. The focus area, Lightweight Warrior Systems, includes a range of technologies related to the sustainment, survivability and support of the soldier. Individual topics include textile technology for multi- functional uniforms and garments, including composite technology for body armor, electronically conductive garments, sustainment systems and power sources.

The topics presented have wide commercial application in addition to military relevance. The offerors should give strong consideration to commercial application of the project results when developing proposals.

MAIL PROPOSALS FOR TOPICS
OSD98-001 THROUGH OSD98-007 TO:

Commander
U.S. Army Natick RD&E Center
ATTN: SSCNC-AE (Gerald Raisanen)
Kansas Street
Natick, MA 01760

OSD98-001 TITLE: Light Weight Warrior Protective Enclosures

TECHNOLOGY: Textile Technology

OBJECTIVE: Apply tubular textile technology to produce a seamless 1-2 soldier enclosure that will provide the warrior with improved protection, reduced weight and cube.

DESCRIPTION: Recent breakthroughs in textile manufacturing technology have demonstrated the ability to fabricate seamless tubular textile structures. This effort will transition emerging technology to the manufacture of a seamless shelter suitable for 1-2 soldiers. Seamless technology will result in faster production rates (reduced cost), reduced weight, reduced cube and the elimination of water leakage associated with seams.

PHASE I: Refine fabric construction to optimize physical characteristics such as weight and strength. Design and fabricate initial prototypes.

PHASE II: Incorporate any design refinements identified in Phase I. Fabricate final prototypes and test in the military and commercial marketplace. Address technical and quality issues related to full scale production.

DUAL USE COMMERCIALIZATION: Commercial backpacking tent manufacturers are constantly trying to reduce the weight of their products while offering the most competitive price. This technology could easily be transitioned into the commercial backpacking tent industry.

REFERENCE:
1. Required performance requirements are included in the purchase description for Tent, Combat, MARCORSYSCOM-PD-97-002, 17 April.
2. "Textiles: Fiber to Fabric, Sixth Edition", Bernard Corbman, 1983.

OSD98-002 TITLE: Multi-threat Protective Uniform System

TECHNOLOGY: Multi-functional Textile Materials, Uniform Systems

OBJECTIVE: To combine emerging material and system design/manufacturing technologies to develop a multi-layer, mission tailorable uniform system with the capabilities and protection necessary to address the environmental, chemical, flame/thermal, electrostatic, POL, and signature detection hazards that may be encountered on the battlefield of the 21st century across a broad temperature range at a 20 percent reduction in weight and bulk over current clothing items.

DESCRIPTION: The military has historically developed clothing items to defeat individual battlefield threats, e.g., cold weather clothing system, separate from a flame resistant uniform system. This results in a soldier requiring many layers of clothing, each providing a specific protection, which is also very heavy and bulky and inhibits soldier combat effectiveness. This effort should characterize the behavior and performance of a system by determining the cumulative effect of state-of-the-art/emerging material technologies on flame/thermal protection, environmental protection and heat stress when combined at the uniform system level, and assessing their impact on the performance of the warrior.

PHASE I: Define materials system alternatives. Test composite system configurations to evaluate their thermal conductivity and moisture vapor permeability characteristics. Determine which configurations provide the most efficient thermal insulation and compatibility with integrated technologies. Conduct Thermal Protective Performance (TPP) testing to measure the performance and behavior of the composite systems under flame. Provide recommendations for optimal material configuration alternatives and the data to support those recommendations.

PHASE II: Utilize best configurations from Phase I to fabricate prototype multifunctional uniform system(s). This may require development of novel manufacturing techniques (seaming) and leveraging novel closure systems technologies. Conduct articulated mannequin testing to evaluate their thermal conductivity and moisture management characteristics under controlled chamber conditions. Conduct flame/thermal testing using Thermo Man and Temperature Regulating System (TRS) to determine the influence of design on the performance of the materials systems under flame and against thermal pulse. Optimize the system and produce prototypes for a field study to assess mobility/maneuverability, durability, and efficiency of the uniform system's ventilation features in aiding thermoregulation and integration with other equipment.

DUAL-USE COMMERCIALIZATION: This systems approach for multi-threat protection has commercial potential in the following markets: Fire fighting service, industrial workers, chemical/HAZMAT, hunting, and recreational sports. This provides opportunities for small businesses to penetrate the textile industry manufacturing base via their technical innovations.

REFERENCES:

1. Endrusick, T. L. and Neilsen, R., (1990), Localized temperatures and Water Vapor Pressures within the Clothing of Working Man in the Cold. U.S. Army Res. Inst. Of Environ. Med., Natick, MA, Oct. 5, Series No. AD-A256 511.
2. Sutphin, Michelle, (1992), Conductive Grids vs. Intimate Blends with Conductive Fibers as Alternatives to Topical Antistatic Treatments, U.S. Army Natick RDEC, Natick, MA Technical Report Number TR-92-029
3. Greene, Charles A. et al, (1992), Operational Forces Interface Group Soldier Enhancement Program, User Evaluation of the Enhanced Hot Weather Battledress Uniform, U.S. Army Natick RDEC, Natick, MA
4. Tucker, David W., Sampson, James B. and Rei, Stephen A., (1990), Front End Analysis of Flame Hazards, U.S. Army Natick RDEC, Natick, MA. Technical Report TR-90-046L, AD B147304L
5. Sampson, James B., Tucker, David W. and Ridgeway, Debra C., (1989), Analysis of Combat Hazards for Balanced Protection, U.S. Army Natick RDEC, Natick, MA. Technical Report TR-90-012L
6. A Technical Information Package (TIP) is available from the Defense Technical Information Center.

OSD98-003 TITLE: Electro Optic Fabric Concepts for Combat Clothing

TECHNOLOGY: Microelectronics, conductive textile materials, fiber optics, micro sensors

OBJECTIVE: Integrate a conductive electronic/optical network within prototype garments constructed from wearable fabric.

DESCRIPTION: The first step to integrate microelectronics into the soldier system is to develop a wearable electronic network. The network will support sensor/monitor and actuator attachments and interconnections fed by a computer processor and transmitter. This effort will develop conductive network materials, sensor attachment techniques, textile seaming methods, and will result in the fabrication of prototype(s) ECG for proof of concept. The network may ultimately support a variety of environmental or chemical sensors, may provide for an active two way antenna system for transmitting and receiving voice/data information, or may supply

power from a central battery to sensors remotely mounted to the soldier's extremities. Future alert detection systems may also require interconnection to a computer processor to signal the soldier of the presence of a mine, the enemy, chemical/biological agents, etc. [Note: Technologies developed may also be applicable to tentage and airdrop fabrics].

PHASE I: The technical feasibility to integrate an electronic network within a wearable fabric will be established. Potential conductive materials, yarn and textile fabrication processes, seaming techniques, sensor mounting and connection technology, distributed chip mounting technology, processor attachment and interconnection technology, and inter-garment electrical and optical interconnect technology and other technologies will be investigated. The most effective materials and processes will be determined and proposed for Phase II efforts. The target garment shall also be comfortable to wear (flexible, lightweight, non-irritating to the skin), resist corrosion and water contamination, and durable to wear and tear. Efforts should be made to shield the network system from electromagnetic interference. The study will result in a trade-off analysis comparing performance, manufacturing, and safety.

PHASE II: The most promising concepts of Phase I will be expanded and laboratory trials conducted. Small quantities of developmental materials and seams will be manufactured and tested. Full-scale manufacturing issues will be resolved and pilot production runs completed. A working prototype garment will be supplied.

DUAL-USE COMMERCIALIZATION: This technology has a potentially wide reaching commercial market as interest in wearable computers spreads from academia to the general public. Developing the textile and microelectronics connection opens the possibility to an infinite number of clothing applications as sensor and software development grows. Specific applications include toxic smoke and intense heat sensors for fire-fighters, toxic chemical sensors for industrial workers, temperature regulating clothing, and a tracking systems for prisoners.

REFERENCES:
1. Pentland, Alex, "Smart Room, Smart Clothes", Media Laboratory, MIT, 20 Ames St., Cambridge, MA, sandy@media.mit.edu, http://www-white.media.mit.edu/vismod
Pentland, Alex, (1996), Smart Clothes, Scientific American, pp 73, April 96

OSD98-004 TITLE: Elastomeric Perm-Selective Materials for Chemical Biological (CB) Protective Clothing.

TECHNOLOGY: Membrane Textile Technology

OBJECTIVE: To develop, demonstrate, and transition elastomeric, selectively permeable materials that will serve as a foundation for one-size-fits-all garments.

DESCRIPTION: Chemically-resistant, waterproof, and breathable polymeric materials with unusually high stretch-and-recoverable ratio and low creeping behavior will be developed for use in the development of a new generation of CB protective clothing and closure system. The resulting materials will be used as stepping-stone foundation for development of a new generation of one-size-fits-all clothing and CB agent-proof closure systems. This will eliminate the needs for overgarment, undergarment, and multiple garment sizes thereby reducing costs, weight, and logistic concerns and problems that soldiers currently face. Selecting a "right" polymeric material that has properties and characteristics as mentioned above has been identified as a major challenge in developing a closure system for CB protective clothing.

PHASE I. Design and analyze experiments using computer assisted software. Formulate and compound material formulations as identified by the experimental design. Produce and test laboratory-size materials (6" wide) for their durability, elastic properties (ability to be stretched and recovered), protective barrier properties toward CB agents in liquid, vapor, and aerosol forms, and their ability to allow diffusion of water vapors. Government-developed test equipment will be utilized in measuring the permeation of water and chemical agent simulant vapors. Identify most promising formula(s). Prepare final report.

PHASE II. Produce scale-up pilot-plant size (40" wide) test material using Phase I's most promising formulation . Laminate stretchable perm-selective materials onto stretchable knit fabric. Fabricate clothing and closure system for functional and field-wear demonstration.

DUAL-USE COMMERCIALIZATION. Produce wide-width (60" wide) fabric. Fabricate and field test garments and closures for soldier's acceptance. The stretchable selectively permeable materials, when incorporated into fabric systems will be very attractive for dual-use in protective clothing applications for military uses, counter-terrorism, law-enforcement, industrial and pesticide chemical handlers/workers. It will also have many spin-off applications in the civilian market where one-size-fits-all concept is attractive and a closure system is needed.

REFERENCES:
1. Storey, R. F. and Shoemake, K. A., "Synthesis and Characterization of Novel Multi-Arm Star-Branched Polymers Based on Poly(Styrene-b-Isobutylene) Block Copolymer Arms," Polymer Preprints, Vol. 37, No. 2, pp. 321-322, American Chemical Society Papers presented at the Orlando, Florida Meeting, Aug 1996.
2. Mauritz, K. A. and Storey, R. F., "Block Copolymer Elastomer/Inorganic Hybrid Materials That are Resistant to Chemical Warfare Agents," U.S. Army Research Office Currently-FundedEPSCoR program (Dr. D. Kiserow's Office), 1996.
3. Brady, T. E., Jabarin, S. A. and Miller, G. W., "Transport Properties of Oriented Poly(Vinyl Chloride)," H. B. Hopfenberg, Permeability of Plastic Films and Coatings to Gases, Vapors, and Liquids, Polymer Science and Technology, Volume 6, p. 301-320, Borden Award Symposium, 1974, Plenum Press, New York and London.
4. Rogers, C. E., Yamada, S. and Ostler, M. I., "Modification of Polymer Membrane Permeability by Graft Copolymerization," H. B. Hopfenberg, Permeability of Plastic Films and Coatings to Gases, Vapors, and Liquids, Polymer Science and Technology, Volume 6, p. 155-166, Borden Award Symposium, 1974, Plenum Press, New York and London.

OSD98-005 TITLE: Pocket-stove

TECHNOLOGY: Combustion

OBJECTIVE: To develop a pocket sized stove that will burn logistics fuels (diesel and JP8) to provide hot water for dehydrated rations, beverages (coffee and cocoa) and limited personal hygiene, and provide basic technology for small heat driven devices including, personnel warmers, heat driven coolers (microclimate and beverages), lanterns, thermophotovoltaic generators, and infrared markers.

DESCRIPTION: Soldiers have no acceptable method for heating water. Trioxane fuel bars have historical supply problems. Commercial camp stoves (8-10K BTU/hour) are too large and heavy for infantry, and none will burn diesel fuel. Accordingly, new approaches and new technology must be explored that will enable a pocket sized stove with an output of 1-2K BTU/hour weighing not more than 4 ounces (2 ounces desired), that connects to a standard fuel bottle (i.e., commercial), that can heat 16 ounces of water in a canteen cup by 100F in less than ten minutes, and that will cleanly and safely burn diesel and JP8.

PHASE I: Establish the basic operating concept through the design and development of a proof-of-principle prototype, demonstrate operation and reliability, and provide strategies to meet all described requirements with minimal risk. Address safety and human factors.

PHASE II: Refine the design to meet all requirements and fabricate 100 prototypes for technical and operational tests. Address manufacturability issues related to full scale production for military and commercial utilization.

DUAL-USE COMMERCIALIZATION: Camp stoves for backpacking are oversized for individual use. Newer models are lighter, but they all rely on the same basic technology. A fundamental change in technology to lower output, size, and weight would revolutionize the industry. Commercial applications also include emergency heating and lighting devices.

REFERENCES:
1. Pickard, D. W., "Development of a Multifuel Individual/Squad Stove," Natick/TR-90/020, February 1990.
2. Fuel, Trioxane, Ration Heating MIL-F-10805
3. Stand, Canteen Cup MIL-S-44221

OSD98-006 TITLE: Evaluation Environment for Light Weight, Low Power Concepts

TECHNOLOGY: Engineering Modeling, Simulation, Computer Aided Design

OBJECTIVE: Investigation and development of a prototype Virtual Evaluation Environment to support engineering level assessment/exploration of individual protective clothing, shelter, and nutritional items in high fidelity simulated settings that accurately recreate actual use environments.

DESCRIPTION: Requirements to fully quantify and assess the potential impacts of new, light weight individual clothing and equipment, food, shelters, and ground mobility items continue to increase. During the envisioned effort an end-to-end virtual evaluation environment will be created that supports exploration of proposed new, changed, or enhanced individual clothing and equipment, food, shelters, and ground mobility items. In this environment the available fidelity will support: examination of the effects resulting from small changes in item characteristics; rapid execution numerous simulation iteration for each set of variable

pairings to establish statistically significance of proposed changes; parametric analysis of potential item characteristic changes; and examination of the relationship between item characteristics changes and changes in human behavior, performance, quality of life, and survivability.

PHASE I: During Phase I the contractor shall: a) examine previous efforts to develop a virtual engineering level evaluation environments; b) identify the required models to build an individual protective clothing, shelter, and nutritional items virtual engineering level evaluation environment; and c) develop a prototype objected oriented architecture for a prototype individual protective clothing, shelter, and nutritional items virtual engineering level evaluation environment.

PHASE II: During Phase II the contractor shall develop, document and demonstrate a prototype individual protective clothing, shelter, and nutritional items virtual engineering level evaluation environment.

DUAL-USE COMMERCIALIZATION: There is a growing need to be able to study, assess, and demonstrate the effect on human behavior, survival and performance that changes in nutrition, clothing, shelter, or activity will have. Offsetting this growing need is an inability, due to regulations and laws, to expose human subjects in many of the exact situations for which the information is most needed. A high fidelity individual protective clothing, shelter, and nutritional items virtual engineering level evaluation environment will allow both military and civilian researchers to better understand the effects proposed changes without unnecessarily expose people to hazardous environments in order to collect data.

REFERENCES:
1. Garcia, A., Goecke, R. Jr., and Johnson, N., Virtual Prototyping, Report of the Defense Systems Management College (DSMC) 1992-1993 Military Research Fellows, Fort Belvoir, VA, DSMC Press, 1994.
2. DMSC Systems Acquisition Manager's Guide for the Use of Models and Simulations, DSMC Press, September 1994.

OSD98-007 TITLE: Polymer Electrolyte Batteries

TECHNOLOGY: Polymer Science, Electrochemistry

OBJECTIVE: To develop rechargeable polymer batteries with high specific energies and specific power, based on polymer electrolytes synthesized by enzyme catalyzed reactions.

DESCRIPTIONS: Future rechargeable batteries for the individual soldier require high specific energies (>150 Wh/kg) and high specific power (>40 W/kg) over a temperature range of -400 C to +700 C. Batteries based on polymer electrolytes have advantages over existing power sources for this application. To meet the above requirements, polymer-based electrolytes require a) high conductivity at the ambient temperatures, b) good physical and thermal stability, c) chemical compatibility with electrode materials, and d) high recharging efficiency. Conductivity of solvent-free polymer electrolytes presently known are too low at ambient temperatures to be useful. The highest conductivity achieved to date is ~10-5 S/cm at room temperature. Hence, there is a need to develop polymer electrolytes with significantly higher conductivity and stability than the present generation materials, and develop batteries from these polymer electrolytes. It is necessary to pursue unusual approaches in order to develop polymer electrolytes having conductivity of the order of 10-3 S cm-1. Studies carried out at Natick with enzyme-catalyzed reactions have indicated that tailored polyaromatic compounds may be synthesized with functional groups (such as carboxylic and sulfonic groups) with well defined molecular weight and dispersity. Polymers synthesized from functionalized monomers are expected to have high conductivity, with good thermal, physical and chemical stability.

PHASE I: Efforts will be to identify monomer candidates with functional groups for the enzyme-based polymerization. Polymers synthesized will be characterized for physical and chemical stability, and electrolyte properties identified. Reaction conditions will be modified for optimum yield, molecular weight and dispersity. Usefulness of the electrolytes for batteries will be demonstrated in laboratory cells.

PHASE II: Efforts will be on formulations of selected polyphenols with different plasticizers to reduce the crystallinity and Tg of the polymer electrolytes. Electrolyte formulations will be evaluated in laboratory cells and prototype batteries. Conductivity of electrolyte formulations developed are expected to be significantly higher than that of present generation

DUAL-USE COMMERCIALIZATION: There are a number of potential applications for light weight rechargeable batteries based on polymers and without the use of toxic and corrosive metals. There is a need for these type of batteries in automobile, electronic parts and devices, and energy sources for survival, safety and communication equipment.

REFERENCES:
1. Akkara, J. A. Senecal, K. and Kaplan, D. L. J. Polymer Sci.: Part A; Polymer Chem. 29, 1561-1574 (1991).
2. Ayyagari, M. S., Akkara, J. A., et al. Macromol. 28, 5192-5197 (1995).

AIR FORCE, ***DEFENSE AIR RECONNAISANCE OFFICE, Advanced Development Division (ADD) / Wright Laboratory***

Technology Focus Area: Airborne Remote Sensing

The Defense Airborne Reconnaissance Office (DARO) is responsible for providing the warfighter assured access to reconnaissance in the theater. This assured access implies new developments in sensors, processing, and communications -- while striving for greater commonality, reliability, and lower life-cycle costs. Achieving this balance between enhanced capability and lower cost is often achieved through selective investment in developing technologies. Often the developing technology is driven by the commercial industry and requires only a modest investment to adapt the technology for airborne applications. One pillar of this investment strategy is the use of SBIRs to foster the necessary research and development of these emerging technologies.

The following SBIR topics support both commercial and military applications for airborne (and spaceborne) remote sensing. These topics represent high risk yet potentially high payoff for both the DARO and the commercial sector. DARO selected these topics based upon the following criteria:

- Crucial to "Airborne Remote Sensing"
- Offer potential for the highest payoff
- Support both DoD and Commercial use

The following topics formed together support areas of interest for the DARO and support the guidelines for the OSD SBIR Technology Transfer Program.

MAIL PROPOSALS FOR TOPICS
OSD98-008 THROUGH OSD98-016 TO: DARO
Attn: Mike Eisman
ASC/RAP Bldg 557
2640 Loop Road West
WPAFB, OH 45433-7106
phone: (937) 255-3575

OSD98-008 TITLE: High Data Rate Solid State Storage of Data

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: The next generation reconnaissance sensors will exceed the capability of the current data storage devices. What is needed, is a high data throughput, low bit error rate (BER), digital storage device capable of operating in an airborne environment.

DESCRIPTION: Advancements in military and commercial sensors have resulted in airborne, space, ground and water based systems that collect a tremendous volume of high-resolution imagery. Mechanical recording systems have to date been used to store and disseminate this data. The amount of data to be collected in the future from a single sensor platform, however, is anticipated to exceed the capability of current and projected mechanical storage systems. In addition, mechanical systems are prone to poor reliability and other system errors (hardware/software, communications errors, processing errors, etc.). Fortunately, recent advances in solid state memory modules could meet the anticipated data storage needs. No work, however, is being done in applying these high density solid state memory modules to airborne data storage devices. The offeror should, therefore, address the requirements, development, and demonstration of a solid state memory system capable of meeting the data storage requirements. The proposed system should be capable of storing 500 Gbps - 1,500 Gbps with an I/O of 3 - 10 Gbps with a maximum Bit Error Rate 1E-14. The system shall be highly reliable, maintainable, power consumption less than 100W, and packaged to fit within a volume of less than 1.5 cubic feet.

PHASE I: Perform industry surveys and meet with customer technical personnel to establish the performance and operational requirements demanded of the solid state system. From this listing of requirements develop a design package clearly describing the desired product.

PHASE II: Execute necessary engineering development on desired unit then build and demonstrate proof-of-concept real-time sensor data acquisition and storage system based on the design package developed in Phase I. Provide a performance assessment which will allow for future extrapolation of the technique to various tactical reconnaissance platforms both manned and unmanned. At the conclusion of Phase II, the government will have a fully developed unit ready for Phase III production and use throughout the field.

DUAL-USE COMMERCIALIZATION: Demonstration of the full potential of this technology promises to provide significant payoff in a broad spectrum of information processing applications having major commercial and military significance. This technology is directly applicable for commercial airborne systems that perform terrain mapping, environmental monitoring, geological sensing, agricultural monitoring, and archeological investigations. This technology directly supports surveillance, reconnaissance, and intelligence communities military requirements for real time acquisition, storage and exploitation of sensor data.

OSD98-009 TITLE: Investigate Using Network Protocols on Asymmetric RF Datalinks.

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: Perform computer simulation and modeling of performance of transmitting/receiving ATM cells through an asymmetric Department of Defense airborne RF data link called the Common Data Link.

DESCRIPTION: The DoD Common Data Link is an asymmetric wideband X or Ku-band RF data link used for airborne-to-ground and airborne-to-airborne data applications. The data link may have 10.7, 137, or 274 megabit/s downlink data rates, but only 5 to 200 kilobit/s uplink rates. The DARO is interested in characterizing the performance and effects of using ATM network protocols with an asymmetric data link such as CDL, to transmit and receive MPEG compressed video, still imagery, or other products in an environment where the bit error rate (BER) could range from 10e-3 to 10e-12, with NSA crypto devices and forward error correction in the data link, with or without jamming.

PHASE I: The offeror shall develop computer modeling and/or simulation software to predict data link performance, limitations, and operational constraints on use leading to a Phase II prototype.

PHASE II: The offeror shall develop a prototype using the technical data developed under Phase I. The prototype shall be tested using DoD equipment to validate Phase I products and predictions.

DUAL USE COMMERCIALIZATION: Application to commercial air transport industry for high rate airborne data communications.

OSD98-010 TITLE: Phased Array Antennas

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: Feasibility of/performance characteristics for Unmanned Aerial Vehicles, manned aircraft, etc., operating with LEO or HEO satellite constellations for air-SATCOM wideband RF data links.

DESCRIPTION: DARO is interested in operating low (10,000 feet) to high altitude (65,000 feet) airborne systems with low earth orbit, medium earth orbit, or high earth orbit communications satellites to reduce size, weight, power, and aperture requirements on the airborne vehicles vice operating with geo-synchronous orbit satellites. Small aperture, twin-beam, steerable, full duplex conformal phased array antennas are an enabling technology to maintain continuous communications with orbiting satellites as they rise above and disappear over the horizon. The hypothesis is that with a twin beam phased array, the air vehicle could electronically switch from communicating with one satellite to the next without a lapse in communications, and without exceeding size, weight, or power constraints. DARO desires to investigate the feasibility of this technology in the 11 GHz to 40 GHz RF spectrum, operating at 2 megabit/s to 600 megabit/s data rates. DARO specifically desires to investigate the possibility of using this antenna technology with future planned systems.

PHASE I: Technical design study, tradeoff analyses, and feasibility assessment of current and projected future state of the art phased array and RF switching technologies of a twin-beam, steerable, full duplex conformal phased array antenna in the 11 Ghz to 40 GHz RF spectrum, operating at 2 to 600 megabit/s data rates to achieve this capability before the year 2010.

PHASE II: Build a prototype antenna system technology for a airborne or static mountain-top demonstration.

DUAL USE COMMERCIALIZATION: Application to commercial air transport industry for high rate airborne data communications.

OSD98-011 TITLE: Small Size, Multifrequency, Multibeam Phased Array Antenna Systems

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: Determine the technical feasibility of using multi-frequency, multibeam full duplex phased array antennas to allow a ground control station to simultaneously receive and transmit data with up to 2,3, or 4 airborne systems, such as Unmanned Aerial Vehicles.

DESCRIPTION: DARO is developing or already has in the inventory systems using C, X, or Ku-band RF data links. Each flying system has an associated unique ground station. DARO desires to investigate the possibility of using a single ground station transmitter to simultaneously send and receive to multiple airborne systems to reduce ground station footprint, uniqueness, and requirement for a one-to-one correlation between airborne system and ground system. Data rates vary from 1.544 megabits/s to 274 megabits/s downlink rates, 64 kilobits/s to 10.7 megabits/s uplink rates. Small physical size suitable for tactical use desired.

PHASE I: Technical design, performance characteristics of, and cost estimates for antenna system.

PHASE II: Technical demonstration of a prototype antenna system.

DUAL USE COMMERCIALIZATION: Commercial shipboard or building top terrestrial uses where accessibility, or space (volume) restricted data communications applications require frequency agility and multiple beams.

OSD98-012 TITLE: Advanced Compact Antenna Technology

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: Demonstrate enhanced antenna element gain for small lightweight synthesize virtual antennas to achieve greater performance than the physical antenna element would allow. The goal is to achieve improved signal-to-noise performance in weak and/or adjacent/co-channel interference environments with very compact antennas.

DESCRIPTION: Develop a mathematical model to support the improved performance of a multi-element synthesized virtual antenna. Develop a single prototype element and a prototype synthesized virtual antenna system. Demonstrate the synthesized virtual antennas capabilities for a small lightweight airborne antenna application.

PHASE I: Develop a mathematical model approach and simple model that demonstrates the improved antenna array performance using synthesized virtual antenna technology. Prototype a single element VHF, UHF, SHF antenna element that demonstrates meaningful improved gain and greater instantaneous bandwidth that can be flush mounted/conformal to flat or curved surface.

PHASE II: Build and demonstrate a prototype antenna system for full characterization in antenna anechoic chamber or antenna outdoor range.

DUAL USE COMMERCIALIZATION: Candidates for dual use include cellular communications and personal/wireless communications. These applications would benefit from the greater bandwidth and/or improved signal-to-noise achievable in a cluttered frequency range.

OSD98-013 TITLE: Object-Level Change Detection

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: Demonstrate processing techniques to determine changes in the presence or position of objects in a scene, while ignoring changes in local or overall scene illumination.

DESCRIPTION: Simple change detection algorithms for imagery may operate by detecting changes in illumination of images. These techniques suffer from false alarms due to differences in illumination conditions between the two frames being compared. Object-level change detection algorithms are based on the ability of the processing to segment an image into areas corresponding to distinct objects. Changes in the status of objects are then detected, due to movement of objects into or out of a scene or within the scene. In addition to the benefits of increased false-alarm immunity, object-level change detection allows a degree of machine understanding of the changes. For example, disappearance of an object in one location and appearance of a similar object in a new

location could indicate object movement.

PHASE I: Propose one or more processing algorithms to detect changes in object status and define several scene conditions of military vehicles under various levels of illumination with vary degrees of background clutter, with partial target obscuration and aspect geometry.. Perform preliminary assessment of the algorithm against these scene conditions.

PHASE II: Conduct a detailed evaluate of the performance of the algorithms against the variety of scene conditions. The algorithms can be used in conjunction with existing government or private sector algorithms that may provide parts of the solution.

DUAL USE COMMERCIALIZATION: Candidates for commercial application of this technology include aided target recognition systems for battlefield awareness, and commercial security monitoring systems.

REFERENCES: SAIP Technical Overview Meeting, March 4,1997, available from DARPA; Moving and Stationary Target Acquisition and Recognition (MSTAR) High Performance Computing Demonstration, April 28, 1997, available from DARPA.

OSD98-014 TITLE: Optimized Data Compression for Hyperspectral Imaging

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: To develop a lossless compression algorithm that utilizes redundant information both spatially and spectrally.

DESCRIPTION: Hyperspectral imagers can now be procured that are both reliable and fairly inexpensive. This technology availability is fostering a revolution in the military and commercial remote sensing community. The biggest hurdle, however, is the volume of data obtained with one of these instruments. Recording or downlinking the raw data is often prohibitively expensive. For many applications, degrading the data by applying a lossy compression, invalidates the results. The desired algorithm should determine the maximum lossless compression possible given the spectral/spatial hypercube and efficiently compress the data. If an asymmetric encoding/decoding scheme is utilized, it would be preferable to have the majority of the computation in the encoding.

PHASE I: Develop an optimized lossless compression scheme for spectral/spatial hypercubes. Phase I should be able to demonstrate the optimal nature of the algorithm via compression of readily available hypercubes and demonstrating its lossless nature.

PHASE II: Implement the compression scheme so as to operate in near real-time on data rates of > 100 Mbits/s. The implementation can consist of field programmable gate arrays (FPGA), ASICs, or other hardware/software that meets the data rates.

DUAL USE COMMERCIALIZATION: Commercial interest in hyperspectral technology is growing quickly. Several commercial enterprises are currently using airborne instruments to monitor agricultural health and environmental monitoring. In addition, several companies are investigating employing hyperspectral imagers in space for remote sensing applications. The compression algorithm developed under this program would reduce the amount of data storage necessary as well as decrease the required communications bandwidth.

OSD98-015 TITLE: Flexible Hyperspectral Dispersive Elements

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: To develop a flexible bandwidth spectral dispersive element.

DESCRIPTION: Exploitation of hyperspectral imagery is currently hampered by the volume of data collected. Current methods detect entire spectrum. however, only certain regions of the spectral information are needed. In fact, most schemes need narrow bands in some regions and only coarse resolution in others. This proposal is to enable the technology for producing low cost custom-design spectral dispersive elements with flexible band centers and bandwidths.

PHASE I: This phase should provide a design including estimates of through-put and spectral cross-talk on the focal plane array using an array of holographic optical elements or rugate interference filters. The design should provide a flexible band centers and bandwidth optimized to spectral bands of interest. The design should minimize the total number detectors for spectral measurements.

PHASE II: Prototype the flexible bandwidth dispersive prototype optical system and demonstrate its performance.

DUAL USE COMMERCIALIZATION: The flexible dispersive optical system is an enabling technology for hyperspectral imaging. The ability to tailor the spectral bandwidths for various commercial applications would allow for a potentially lower cost, more compact system to be fielded for remote sensing applications.

OSD98-016 TITLE: Optical Field Flatteners for IR Hyperspectral Sensors

TECHNOLOGY: Airborne Remote Sensing

OBJECTIVE: To produce a high-quality, low cost field flattener for infrared hyperspectral sensors.

DESCRIPTION: The dispersion elements for hyperspectral sensors separate the spectrum in angle. Focal planes, however, are 2-D detectors with pixels of constant dimensions. These attributes force a trade between preserving spectral bandwidth constancy and having a wide field-of-view (FOV) system. Conventional glass field flatteners cannot accommodate the larger field curvatures. This effort will concentrate on using IR optical fibers to provide the necessary field flatness.

PHASE I: Optical fibers have been used in the visible as field flatteners in the 0.4-1.0 micron region. Optical glass exists in the SWIR region and some fibers have been extruded. The Phase I effort will investigate potential SWIR glass fibers (1.0-2.5 microns) and measure the transmission and insertion losses. System performance will be estimated for a hyperspectral system employing the SWIR optical fibers as field flatteners.

PHASE II: A fiber optical bundle will be integrated into a wide FOV SWIR hyperspectral sensor. The goal is to provide a minimum of 45° FOV. Throughput, spectral purity, and spatial MTF will be measured.

DUAL USE COMMERCIALIZATION: Providing a low cost, wide FOV IR hyperspectral system will impact two commercial areas. The first is the burgeoning commercial remote sensing industry utilizing aircraft and spacecraft. The second field is in nondestructive testing which utilizes the spectral information to verify yield and quality in many material formation and fabrication processes.

NAVY, ***Theater Air Defense PEO - Naval Surface Warfare Center, Dahlgren Division***

Technology Focus Area: Modeling and Simulation

Modeling and Simulation processes, methods, tools, and environments are needed for engineering large-scale, distributed, complex systems consisting of a heterogeneous mix of physical processes (sensor, communications and control, actuators) interacting with a dynamic environment. The principal Theater Air Defense application domains that embody systems of systems characteristics are Theater Ballistic Missile Defense, Littoral Battle-Space, and Global Command and Control. Other DOD applications include Total Ship System Engineering, Expeditionary Warfare, and Information Warfare. Corollary application domains in the commercial sector include air traffic control, telecommunications, electrical utilities, rapid transit systems. Typically, each component within the systems needed to address the foregoing problem domains is a system itself. A high degree of connectivity and computing capability is required in order to support the information and decision making processes in such systems. Complexity exists at different levels within the system of systems architecture, creating a tendency toward mathematical intractability in the analysis and design of these systems. A broad range of stakeholders must be enabled to participate effectively in the development and deployment processes in order to assure that the product delivered satisfies the original requirements. Integrated product teams (IPT) representing a number of engineering disciplines must employ a disciplined approach in a concurrent engineering fashion to engineer the intended product.

Integrated enterprise environments based on advanced information technologies must support the employment of processes, methods, and tools which assure management of complexity and enable IPT's to perform design synthesis, evaluation and assessment, and life-support of large scale systems. These environments must leverage the best available modeling and simulation technology in order to support engineering analyzes for large-scale systems without the need for extensive prototyping in hardware and software of candidate designs.

The following topics support the commercialization of advanced systems of systems modeling and simulation methods and tools for both DoD and the private sector.

Mail Proposals for Topics #OSD98-017 through OSD98-020 to:

Ron Vermillion
Naval Surface Warfare Center
Code B04, Bldg. 1470/1104
17320 Dahlgren Rd.
Dahlgren, VA 22448-5100

OSD 98-017 TITLE: Information Flow Analysis Capability

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Develop information flow analysis capability to define, chart, analyze, and visualize the information elements flowing among a set of objects (platforms, systems, human decision makers) in a complex-adaptive theater warfare system.

DESCRIPTION: A military theater of operation is a complex, dynamic, system of interacting objects constantly adapting to changes in the theater environment. These adaptations are based on the various objects in the theater system acquiring information about the environment, identifying patterns in that information, defining action models based on those patterns, and making decisions to act in some manner on the basis of those models. This process occurs with the human decision makers throughout a chain of command as well as the systems those decision makers use to support their actions. Understanding the information flow and the interactions of information elements within this complex and ever-changing environment is critical to being able to conceptualize and design theater systems and processes.

PHASE I: Define system modeling and analysis processes by which information elements may be defined from functional requirements, how elements are related, and how elements are derived from other elements thru correlation or fusion schemes (both machine and human). Show visually these processes, especially the flow of information from one subsystem to another. Demonstrate how the interaction of information elements influences their evolution over time. Present possible designs for an Information Flow & Analysis Tool. The designs should take advantage of current WEB and database technology, be based on a modular architecture, and be capable of interfacing with wargame simulation systems.

PHASE II: Develop and test the Information Flow and Analysis Tool based on the Phase 1 design. The tool should demonstrate a basic capability to define information flows and to be able to visualize those flows and their various interactions so that the uninitiated can grasp an overall understanding of the information environment of a complex theater of operation. The tool should also demonstrate an ability to support the analysis of information flows. Phase 2 will also demonstrate the tools ability to interface with an existing theater simulation system.

DUAL-USE COMMERCIALIZATION: This system has great commercial and DoD potential in supporting the conceptualization and design of various complex, information- rich systems where humans are responsible for making key decisions. Candidate applications include private sector financial and investment systems or military data banks and fire control solutions.

REFERENCES:
Lectures in the Science of Complexity, Ed. D. Stein, Addison-Wesley, 1989"Theory and Applications of Information-Based Complexity" by J. F. Traub and H. Wozniakowski, 1990
Lectures in Complex Systems, Edited by L. Nadel and D. Stein, Addison-Wesley, 1991

OSD 98-018 TITLE: Visualization of the Effects of Architectural Failure for Large-Scale High Assurance Systems

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: To provide engineers with tools which will aid early understanding of how large, complex systems can fail.

DESCRIPTION: It has been known for years that the earlier that errors in requirements (also design and implementation) are discovered, the less costly they are to fix. By integrating failure analysis tools with modeling and simulation tools which provide for visualization of behavior, the goal of early recognition of requirements and design errors can be realized. The result of this effort will help fully integrate failure analysis into the system development process, thus aiding the understanding of the behavior of large, complex systems when subsystems fail.

PHASE I: Survey the literature for techniques, methods, and tools which could serve as candidates for integration with existing visualization tools. Construct a framework for the visualization of system failure, and plan the development of an initial prototype. The plan will include the identification of the major semantic issues to be overcome in the tool integration process.

PHASE II: Implement the Phase I plan: perform the tool integration, and build a prototype to demonstrate the utility of the concept. Provide support for a Navy Program using the prototype. This will serve as an initial transition to the Navy.

DUAL-USE TECHNOLOGY: Application of the tool to Navy programs, such as theater missile defense, or large platform procurement such as the SC-21 or CV-X. Commercial applications include aircraft and telecommunications systems design.

REFERENCES:
1. Design and Analysis of Fault Tolerant Systems, by Barry W. Johnson, Addison-Wesley Publishing Company
2. "Real-Time Object-Oriented Modeling", Bran Selic, Garth Gullekson, Paul T. Ward, John Wiley & Sons Inc., 1994.

OSD 98-019 TITLE: Human Engineering Tools for Engineering of Complex Systems

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: The purpose of this project would be to develop an integrated set of performance prediction, performance evaluation, workload assessment, and decision support tools for assessing the human engineering aspects of US Navy and commercial system designs within a "systems engineering" (SE) framework. The tool set will be used to evaluate reduced manning and automation concepts for new and evolving large-scale designs.

DESCRIPTION: The Navy needs tools to plan for, design, and evaluate alternative manning and automation concepts (with the goal of reducing crew sizes) prior to implementing specific technologies and designs. While there are a number of tools currently available that can provide designers and analysts with assistance in evaluating these issues, the currently available tools fall short in several key areas. 1) Available tools are not specifically applicable to human system integration issues associated with shipboard manning and the unique team requirements and associated workload issues. 2) Those tools that do exist are designed more for post-design analysis, versus engineering the human operator into the design at the outset. 3) Human engineering considerations of the operator as an integral "system" component are not yet supported in any systems engineering tool sets.

An integrated tool set that can perform some set of the following functions will greatly augment current system modeling and analysis capability: a) capture and articulate engineering requirements specific to the human operator, b) weigh the costs and benefits of human operators against automation, c) create candidate display concepts (based upon human factors principles), d) provide performance modeling, and e) perform individual and team workload analyses (including cognitive, perceptual, and motor workload). This integrated tool set must be compatible with existing databases of shipboard tasks and performance elements. Additionally, it must be capable of interacting with typical system engineering models.

This set of analytical tools for evaluating automation alternatives in quantitative, unambiguous terms would predict which

alternatives would be most likely to result in successfully reducing manning within the domain of safe and effective shipboard operations. These tools are needed to address the allocation of functions and tasks to humans and to advanced technologies, evaluate the design of workstations, interfaces, jobs and procedures, as well as identify additional training requirements resulting from the introduction of new technologies.

PHASE I: Define the requirements for a toolset and define requisite information necessary to support tool development and usage. Identify candidate tools and develop estimates of manpower required to use the tools.

PHASE II: Implement a prototype integrated human engineering toolset in a commercially available workstation environment. Demonstrate the capability of the tools to address human engineering aspects of Navy systems.

DUAL-USE COMMERCIALIZATION: Potential applications include Navy (NSWCDD) ship acquisition to evaluate reduced manning and automation concepts for new and evolving ship designs. While manning reduction for the Navy is the primary thrust for this effort, applications include other stressful team environments such as air traffic control, nuclear power control, and crisis management centers.

OSD 98-020 TITLE: Virtual Prototyping Environments for The Development of Systems of Systems.

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Develop an integrated engineering environment which provides new capabilities to enable the prediction and evaluation of total system performance as well as system design trade-offs. Apply modeling and simulations, synthetic environment, and virtual reality technology to the implementation of virtual prototyping capabilities for the design, manufacture and test of systems of systems.

DESCRIPTION: Virtual Reality (VR) technology is advancing and maturing very quickly. VR technology is now being invested in and applied in many fields such as engineering, manufacturing, chemistry, aerospace, and medicine. The two greatest benefits of this technology have been significant reduction of cost and development time in these engineering disciplines. However, VR has not been substantially utilized in the area of system engineering. Because system engineering deals with large, complex, real-time systems of systems, the greatest benefits is in cost reduction in the system development process. This effort will develop and apply VR technology in concert with system modeling and analysis tools for application to integrated system engineering environments to enable virtual prototyping, virtual manufacturing, and virtual testing of candidate large-scale system designs. The following capabilities are critical in supporting virtual engineering environments:

a) Generic infrastructure and system engineering life-cycle support for large scale real-time systems
b) Distributed simulation support for integrated battlespace engineering and analysis
c) Resource optimization for large scale information systems
d) Wide area collaborative system engineering
e) Configuration management for distributed large, complex, real-time federated systems architectures

PHASE I: Perform a feasibility study and implementation specification for the development of Virtual Prototyping Environments. Develop specification and implementation plans and a recommendation for Phase II implementation.

PHASE II: Develop, test and demonstrate initial Virtual Prototyping Environment specified in Phase I effort for small or medium scale architecture.

DUAL-USE COMMERCIALIZATION: Application to Navy system acquisitions (e.g., SC21, CVX, LPD-17, NSSN). This application of VR is useful to any industry which engages in system engineering (e.g., the aerospace engineering and telecommunications industries).

REFERENCES:
1. Slater M., Usoh M. (1994) Body Centered Interaction in Immersive Virtual Environments, in "Artificial Life and Virtual Reality", Eds. N. Thalmann and D. Thalmann, John Wiley & Sons, England, 1994, pp125-147.
2. Department of Defense: High Level Architecture Object Modeling Template Version 0.3 Defense, Modeling and Simulation Office. Alexandria, VA. May 1996
3. Department of Defense: High Level Interface Specification (Version 0.4) Defense, Modeling and Simulation Office, Alexandria, VA.
4. The Common Object Request Broker: Common Object Services Specification. Object Management Group. OMG Document Number 95-3-31, March 31, 1995

Technology Focus Area: Health Monitoring of Navy Aircraft

The costs associated with a Safe Life maintenance philosophy are very high. As our fleet ages beyond their original design life these costs will continue to escalate as dictated by the ever shrinking inspection intervals. The need to move from a Safe Life maintenance philosophy to a Condition Based Maintenance (CBM) philosophy is imperative if we want to reduce life cycle costs while maintaining fleet readiness. As we approach the design life of existing platforms, Life Assessment Programs (LAP) will determine the condition of the platform. In many case this programs will be followed by Life Extension Programs (LEP). As part of the LEP, the specific platforms will go through a completely tear down giving the opportunity of installing CBM system. We must now develop such Health Monitoring System in order to integrate them in the LEP programs as they start developing in the near future. As part of this SBIR the following topics will be considered for award:

Distributed Crack Initiation and Growth Monitoring System
1. Distributed Corrosion Monitoring System
2. Distributed Bond line Monitoring system
3. Health Monitoring of Rotating Engine Parts

Mail Proposals for Topics #OSD98-021 through OSD98-024 to:

Carol Van Wyk
Naval Air Warfare Center - Aircraft Div R&D
22541 Milstone Road, Attn Code: 40C/T
Patuxent River, MD 20670-5304
(301) 342-0215

OSD 98-021 TITLE: Distributed Crack Initiation and Growth Monitoring System

OBJECTIVE: To develop a Distributed Acoustic Emissions (AE) monitoring system for the detection of cracks in metallic structural components using advance sensor techniques such as fiber optic sensors. The main requirements of this system is that all the sensors will be powered and interrogated with a single line such as a single optical fiber or a single coaxial cable. The system will be sensitive to frequencies in the 100KHz to 1 MHz band and it will detect the AE events in the presence of quasi-static loading. The loading state will also be determined using the same sensor system

DESCRIPTION: A system for reliably detecting cracks in aging aircraft structures and in next generation fighters is critically needed. AE monitoring is the only proven method of detecting cracks in metals without having to place the sensor directly in top of the cracks. However, present AE monitoring systems suffer from various limitations. Each sensor need two wire leads to pick up the signal, the wire leads have to be heavily shielded to avoid EMI, each sensor needs a pre-amplifier and signal conditioner nearby, two more wire leads are required for each amplifier. Techniques that use fiber optic Bragg gratings offer the opportunity of solving all these limitations. A single optical fiber will have embedded in it various Bragg grating sensors, all sensors will be interrogated using a single laser beam, and since there is no attenuation in the fiber there will be no need for pre-amplifiers or signal conditioners. Also, the system does not require EMI shielding since it is optical in nature.

PHASE I: In Phase I the contractor will demonstrate that he can monitor acoustic emissions in a loaded Aluminum panel by using the advanced sensor concept. The system will have a minimum of three sensors in a single power line. Acoustic emissions will be simulated by performing pencil break tests and/or by producing short burst of energy form an ultrasonic transducer. In the second case, the central frequencies of the burst will range from 100KHz to 1MHz in steps of 100KHz with approximately a 150KHz Band Width. The loading level will range from 10% to 60% of the yield strength of the aluminum plate. The sensitivity of the system will be compared theoretically and experimentally to that of a standard single channel AE transducer.

PHASE II: In Phase II the contractor will develop all the necessary optical and electronic components for a 10 channel Acoustic Emission monitoring system. It is advised at this point that the contractor team up with a airframe manufacturer interested in transitioning this new technology.

PHASE III: A health monitoring system of this nature could be installed in any DoD platform (F18, F14, F16, F15) which has a structural component (such as a bulkhead) that requires periodic inspections to ensure the lack of cracks. Significant cost savings could be achieved by the installation of this system by performing maintenance at longer time intervals or only when the system indicates that it is required.

COMMERCIAL POTENTIAL: Commercial aviation would benefit significantly from a system of this nature as well. Wide spread fatigue damage has been determined to be a major source of problem for commercial aviation.

REFERENCES:

1. "Fiber Optic Bragg Grating Model", I. Perez, T.F.A. Bibby, M. Ryan, Report No. NAWCADWAR-95027-4.3
2. Proceeding of "Smart Structures and Materials 1997" Sponsored by the SPIE Soc. - San Diego, CA, 3/97
3. ASTM-E976

OSD 98-022 TITLE: Distributed Corrosion Monitoring System

OBJECTIVE: To develop a distributed Corrosion Monitoring system capable of detecting the occurrence of corrosion in key structural components and monitoring its evolution and severity.

DESCRIPTION: It is well known that stress-corrosion cracking and corrosion fatigue can significantly reduce the life expectancy of structures. Therefore, it is critical to develop a monitoring system which can reliably and accurately detect the amount of corrosion experienced by a structure. In this way early and economic repairs can be performed to the structure at the same time that the useful life of the structure is extended. System concepts should be capable of detecting and monitoring the evolution of corrosion in hidden aircraft structural components such as inside lap joints, around fasteners and under aircraft skins.

PHASE I: In phase I a proof of concept will be performed. The amount of corrosion will be monitored in an environmental or salt spray chamber.

PHASE II: In Phase II a prototype Distributed Corrosion Monitoring system will be developed. System will be demonstrated in a fleet aircraft.

PHASE III: Phase III will identify funding source to transition this technology to NAVAIR and find a suitable industrial partner to develop a manufacturing process

COMMERCIAL POTENTIAL: A system of this nature has enormous applications in the civilian aviation sector by monitoring corrosion in aging aircraft's. This type of system could also monitor corrosion in bridges, pressure vessels, an in explosive environments where electrical sensor might produce a hazard.

OSD 98-023 TITLE: Distributed Adhesive Bond Monitoring System

OBJECTIVE: To develop a distributed health monitoring system capable of monitoring the integrity of adhesively bonded structures.

DESCRIPTION: The cost associated with periodic inspection of aircraft structures is astronomical. This cost will continue to rise as our fleet ages further with no new replacements for the short term. A health monitoring system could significantly reduce the cost of ownership by reducing or eliminating periodic inspections and replacing them with on demand inspections. Also the reliability of detection would be increased because the damage location could be triangulated before hand. The inspection time would be reduced because only the damaged site would be inspected and repaired.

PHASE I: In Phase I the contractor will demonstrate the proposed concept for monitoring the integrity of bond lines. The contractor will use standard aerospace adhesives (such as FM300 and AF191) and materials (such as Al7075 and Graphite epoxy composites) to demonstrate the technique.

PHASE II: In Phase II a prototype Distributed Adhesive Bond Monitoring system will be developed. System will be demonstrated in a fleet aircraft.

PHASE III: Phase III will identify funding source to transition this technology to NAVAIR and find a suitable industrial partner to develop a manufacturing process

COMMERCIAL POTENTIAL: A system of this nature has enormous applications in the civilian aviation sector by monitoring adhesively bonded structures in aircraft wings, fuselage, pressure vessels, an in explosive environments (fuel tanks) where electrical sensor might produce a hazard.

OSD 98-024 TITLE: Health Monitoring of Rotating Engine Parts

OBJECTIVE: To develop a distributed health monitoring system capable of monitoring the integrity of moving engine parts. The sensor system will be permanently installed in the engine and will have to compatible with the engine environment.

DESCRIPTION: The cost associated with periodic inspection of aircraft engines is astronomical. This cost will continue to rise as our fleet ages further with no new replacements for the short term. A health monitoring system could significantly reduce the cost of ownership by reducing or eliminating periodic inspections and replacing them with on demand inspections. Also the reliability of detection would be increased because the damage location could be triangulated before hand. The inspection time would be reduced because only the damaged site would be inspected and repaired.

PHASE I: In Phase I the contractor will demonstrate the innovative concept in a rotating turbine engine disk with blade. The contractor will demonstrate that when a small flaw (crack) is introduced in the disk or blade, his sensor system will be capable of detecting it.

PHASE II: In Phase II a prototype Rotating Engine Part Health Monitoring system will be developed. System will be demonstrated in a fleet aircraft.

PHASE III: Phase III will identify funding source to transition this technology to NAVAIR and find a suitable industrial partner to develop a manufacturing process

COMMERCIAL POTENTIAL: A system of this nature has enormous applications in the civilian aviation sector by monitoring rotating engine parts.

9.0 SUBMISSION FORMS AND CERTIFICATIONS

Section 9.0 contains:

Appendix A: **Proposal Cover Sheet**
Appendix A (or photocopy) must be signed and included with each proposal submitted.

Appendix B: **Project Summary Form**
Appendix B (or photocopy) must be included with each proposal submitted. Don't include proprietary or classified information in the project summary form.

Appendix C: **Cost Proposal Outline**
A cost proposal following the format in Appendix C must be included with each proposal submitted.

Appendix D: **Fast Track Application Form**
A DoD pilot program under which projects that attract outside investors receive interim funding and selection for Phase II award provided they are "technically sufficient" and have substantially met Phase I goals.

Appendix E: **Company Commercialization Report**
A report that identifies each Phase II SBIR and/or STTR project your firm has received, and Phase III sales and/or funding resulting from each project. All Phase I and Phase II proposals must include a Company Commercialization Report.

Reference A: **Proposal Receipt Notification Form**

Reference B: **DTIC Information Request Form**

Reference C: **Directory of Small Business Specialists**

Reference D: **SF 298 Report Documentation Page**

Reference E: **DoD Fast Track Guidance**

Reference F: **DoD's Critical Technologies**

Reference G: **DoD SBIR/STTR Mailing List Form**

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to fill in all appropriate
spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____________________

____

FIRM NAME: ____________________

MAIL ADDRESS: ____________________

____

CITY: ____________________ STATE: ________ ZIP: ________

PROPOSED COST: ____________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	▯	▯
▸ Are you a socially and economically disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	▯	▯
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	▯	▯
▸ Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	▯	▯

____________________ ____________________

____________________ ____________________

▸ Number of employees including all affiliates (average for preceding 12 months): ____________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ____________________	NAME: ____________________
TITLE: ____________________	TITLE: ____________________
TELEPHONE: ____________________	TELEPHONE: ____________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____________________

Before signing below, please read the cautionary note at Section 3.7

SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following type styles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and submit the Appendix A and B forms as pages 1 and 2 of each proposal. In addition, (4) complete copies of the proposal must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

Failure to fill in all appropriate
spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words or short (2-3 word) phrases that describe the Project.

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following type styles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and submit the Appendix A and B forms as pages 1 and 2 of each proposal. In addition, (4) complete copies of the proposal must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Subcontracts (e.g., consultants)
    a. Identify each, with purpose, and dollar rates
    b. Total estimated subcontracts costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION COVER SHEET

Failure to fill in all appropriate spaces may cause your application to be disqualified

To qualify for the SBIR Fast Track, a company must submit a Fast Track application and meet the other requirements detailed in Section 4.5 of the solicitation. This form, when completed and signed by both the company and its investor, should be included as the cover sheet of the Fast Track application. Instructions on where to submit the application are on the back of this form.

TOPIC #: ______________ CONTRACT #: ________________________ PHASE I EFFECTIVE START DATE: ________________

SPONSORING DOD COMPONENT: ____________________________ PHASE I COMPLETION DATE: ________________

PHASE I TITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

CITY: ______________________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ________________________

NAME OF OUTSIDE INVESTOR: ____

MAIL ADDRESS: ____

CITY: ______________________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ________________________

BUSINESS CERTIFICATION:

	YES	NO
▸ Has your company ever received a Phase II SBIR or STTR award from the federal government (including DoD)? If yes, the minimum matching rate is $1 for every SBIR dollar. If no, the minimum matching rate is 25 cents for every SBIR dollar.	☐	☐
▸ Does the outside funding proposed in this application qualify as a "Fast Track investment", and does the investor quality as an "outside investor", as defined in DoD Fast Track Guidance (Reference E)? If you have any questions about this, call the DoD SBIR Help Desk (800-382-4634). The Help Desk will refer any policy and/or substantive questions to appropriate DoD personnel for an official response.	☐	☐

Caution: knowingly and willfully making any false, fictitious, or fraudulent statements or representations above may be felony under the Federal Criminal False Statement Act (18 U.S.C. Sec 1001), punishable by a fine of up to $10,000, up to five years in prison, or both.

PROPOSED SBIR AND MATCHING FUNDS:

- Proposed DoD SBIR funds for the interim effort: $________________
- Proposed DoD SBIR funds for Phase II: $________________
- Total proposed DoD SBIR funds (interim + Phase II): $________________
- Amount of matching funds (cash) the investor will provide: $________________

By signing below, the parties are stating that the outside investor will provide matching funds, in the amount listed above, contingent on the company's selection for Phase II SBIR award. If the matching funds are not transferred from the investor to the company within 45 days after DoD has notified the company that it has been selected for Phase II award, the company will be ineligible to compete for a Phase II award not only under the Fast track but also under the regular Phase II competition, unless a specific written exception is granted by the Component SBIR program manager.

COMPANY OFFICIAL	OUTSIDE INVESTOR OFFICIAL
NAME: ________________	NAME: ________________
TITLE: ________________	TITLE: ________________
TELEPHONE: ________________	TELEPHONE: ________________
________________ SIGNATURE ________ DATE	________________ SIGNATURE ________ DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX D

SUBMISSION:

Submit the Fast Track application, including the three items discussed in Section 4.5(b), to the technical monitor for your Phase I project. In addition, submit a copy of the entire application to the Program Manager of the DoD Component funding the SBIR project (addresses below). Finally, send a copy of this application cover sheet, when completed, to the DoD SBIR Program Manager, 3061 Defense Pentagon, Room 2A338, Washington, DC 20301-3061. Do not submit other items in the Fast Track application to the DoD SBIR Program Manager.

Department of the Army
Dr. Kenneth A. Bannister
Army SBIR Program Manager
Army Research Office - Washington
5001 Eisenhower Avenue, Room 8N23
Alexandria, VA 22333-0001

Department of the Navy
ONR 362 SBIR
800 N. Quincy Street
Arlington, VA 22217-5660

Department of the Air Force
AFPL/XPXP, Suite 6
ATTN: R.J. Dickman
Wright Patterson AFB, OH 45433-5006

Defense Advanced Research Projects Agency
ATTN: SBIR Program Manager Ms. C. Jacobs
3701 N. Fairfax Drive
Arlington, VA 22203-1714

Ballistic Missile Defense Organization
ATTN: TOI/SBIR (Bond)
1725 Jefferson Davis Highway
Suite 809
Arlington, VA 22202

Office of the Director, Defense Research and Engineering
Lab Management & Tech Transition
ATTN: SBIR Program Manager
3040 Defense Pentagon
Washington D. C. 20301-3040

Defense Special Weapons Agency
ATTN: AM/SADBU, Mr. Bill Burks
6801 Telegraph Road
Alexandria, VA 22310-3398

US Special Operations Command
ATTN: SOSB/Ms Karen L. Pera
7701 Tampa Point Blvd.
MacDill AFB, FL 33621-5323

REQUEST FOR COPIES OF THIS FORM:

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COMPANY COMMERCIALIZATION REPORT

Failure to fill in all appropriate spaces may cause your proposal to be disqualified

FIRM NAME: ______________________

MAIL ADDRESS: ______________________

CITY: ______________ STATE: ________ ZIP: ________

- How many Phase II SBIR or STTR awards has your firm received from the Federal Government (including DoD)? (The answer "none" will not affect your ability to obtain an SBIR award.) ________
- If your firm has received 5 or more Phase II SBIR and/or STTR awards from the Federal Government and the first award was received prior to Jan. 1, 1991, what percentage of your firm's revenues during your last fiscal year is Federal SBIR and/or STTR funding (Phase I and/or Phase II)? ________
- Identify each Phase II SBIR and/or STTR project your firm has received and, for each project, provide the total revenue to date from resulting sales of new products or non-R&D services to DoD or its prime contractors, other government agencies, and private sector customers. Also provide total <u>non-SBIR, non-STTR</u> funding received from government and private sector sources to further develop the SBIR technology (including R&D, manufacturing, marketing, etc.). Apportion sales revenue and non-SBIR, non-STTR funding among the various Phase II projects without double-counting. (See back for further instruction.)

Agency: ________ Topic Number: ________ Contract Number: ________

Project Title: ______________________

DoD/Primes Sales: ________ Other Gov't Sales: ________ Private Sector Sales: ________

non-SBIR/STTR Gov't Funds: ________ non-SBIR/STTR Private Sector Funds: ________

Agency: ________ Topic Number: ________ Contract Number: ________

Project Title: ______________________

DoD/Primes Sales: ________ Other Gov't Sales: ________ Private Sector Sales: ________

non-SBIR/STTR Gov't Funds: ________ non-SBIR/STTR Private Sector Funds: ________

Agency: ________ Topic Number: ________ Contract Number: ________

Project Title: ______________________

DoD/Primes Sales: ________ Other Gov't Sales: ________ Private Sector Sales: ________

non-SBIR/STTR Gov't Funds: ________ non-SBIR/STTR Private Sector Funds: ________

Agency: ________ Topic Number: ________ Contract Number: ________

Project Title: ______________________

DoD/Primes Sales: ________ Other Gov't Sales: ________ Private Sector Sales: ________

non-SBIR/STTR Gov't Funds: ________ non-SBIR/STTR Private Sector Funds: ________

Agency: ________ Topic Number: ________ Contract Number: ________

Project Title: ______________________

DoD/Primes Sales: ________ Other Gov't Sales: ________ Private Sector Sales: ________

non-SBIR/STTR Gov't Funds: ________ non-SBIR/STTR Private Sector Funds: ________

FIRM CORPORATE OFFICIAL

NAME: ______________ TELEPHONE: ______________

TITLE: ______________ FAX: ______________

Before signing below, please read the cautionary note at Section 3.7

______________________ ____________
SIGNATURE OF FIRM CORPORATE OFFICIAL DATE

(Page ____ of ____)

INSTRUCTIONS FOR COMPLETING APPENDIX E

General:

The Company Commercialization Report (Appendix E) shall NOT be counted toward proposal page count limitations.

Appendix E should be the last page(s) of your proposal.

Use as many Appendix E forms as needed to report ALL Phase II projects. (Make black and white copies of this form, if necessary.) If multiple pages are submitted, fill in the "Page___of___" in the lower right corner.

Type in either a 10 or 12 characters per inch font.

Carefully align the forms in the typewriter using the underlines as a guide.

Use the Post Office two-letter abbreviation for the state (i.e. type NY not New York).

Definitions:

Sales - sales of products or non-R&D services resulting from the technology associated with this Phase II project. Sales also includes the sale of technology or rights. Specify the sales revenue in dollars (1) to the DoD and/or DoD prime contractors, (2) to other government agencies (federal, state, local and/or foreign), and (3) to the private sector. Include sales made by your firm as well as by other firms that may have acquired the SBIR-developed technology. (e.g., spin-off companies, licensees, etc.)

non-SBIR/STTR funding - non-SBIR/non-STTR government or private sector funds to further develop the technology (including R&D, manufacturing, marketing, etc.) associated with this Phase II project.

Apportion sales/funding - If two or more Phase II projects contributed to a single products or technology right that has been sold or received non-SBIR, non-STTR funding, divide proportionately the sales or funding among the contributing projects. For example, Phase II projects A and B lead to the sale of a new product "Widget" to the Army for a total of $10 million and to retail software stores for $12 million. Under the heading "DoD/Primes Sales:" put $5 million and under the heading "Private Sector Sales:" put $6 million for both Phase II projects A and B.

non-R&D Services - any services that do not include additional R&D work on the SBIR technology -- for example, engineering services, study and analysis, information services.

Submission:

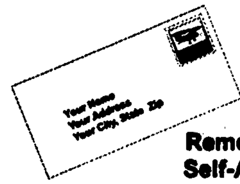
ALL Phase I and Phase II proposals must include a Company Commercialization Report (Appendix E). Please do not submit supplemental material.

Request for Copies:

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

Proposer: If you wish to be notified that your proposal has been received, please submit this form with a stamped, self-addressed envelope.



Remember to Stamp Your Self-Addressed Envelope!

TO: ______________________________________

____

____

Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 98.1

Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____

Fill in name of organization to which you will send your proposal.

______________________________________ ____________

Signature by receiving organization Date

DEFENSE TECHNICAL INFORMATION CENTER

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR TECHNICAL DOCUMENT SERVICES

Small Businesses are encouraged to obtain Technical Information Packages (TIPs), annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). A TIP is prepared for each SBIR topic. TIPs are free; a small business may order as many as needed. The technical reports cited in a TIP cover DoD-funded work related to the particular topic. Ten technical reports may be obtained at no cost from DTIC during SBIR Solicitations. See section 7.1 for a more detailed description of TIPs and other valuable SBIR services available from DTIC.

1. You may fold, stamp and mail this form. Remember, significant mailing delays can occur.

2. For faster service, you may also telephone, fax or Email requests, or obtain TIPs from the DTIC SBIR Web site.
   Phone: 800-363-7247
   FAX: 703-767-8228
   Email: sbir@dtic.mil
   WWW: http://www.dtic.mil/dtic/sbir

3. Technical reports of interest, in addition to those cited in the TIPs, can be identified using Public STINET, the online technical reports database, available on the DTIC SBIR web site. A large selection of Full-Text Documents, including many related to SBIR topics, is also available on the web site.

4. DTIC provides technical services under the SBIR program year-around. Authorization to provide free hard copy is in effect during solicitations only.

REQUESTER ____
Name

ORGANIZATION NAME ____

ADDRESS ____
Street

____ PHONE ____________________
City State Zip Code Area Code/Number

FAX ____________________ EMAIL ______________________________

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER	TOPIC NUMBER	TOPIC NUMBER	TOPIC NUMBER
1 ________	5 ________	9 ________	13 ________	17 ________
2 ________	6 ________	10 ________	14 ________	18 ________
3 ________	7 ________	11 ________	15 ________	19 ________
4 ________	8 ________	12 ________	16 ________	20 ________

I confirm that the business identified above meets the SBIR qualification criteria in Section 2.2 of the DoD Program Solicitation.

Signature of Requester: ______________________________

==================FOLD HERE==================

STAMP

Return Address

ATTN: DTIC SBIR
Defense Technical Information Center
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218

==================FOLD HERE==================

REF B

Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd., Suite 1107
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMC San Francisco
ATTN: Joan Fosbery
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7042

DCMC San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 100
San Diego, CA 92111-2241
(619) 637-4922

DCMC Seattle
ATTN: Alice Toms
3009 112th Ave., NE, Suite 200
Bellvue, WA 98004-8019
(206) 889-7317/7318

DCMC Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92172-2700
(714) 836-2913 (ext. 659 or 661)

DCMC Van Nuys
ATTN: Dianne Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 756-4444 (ext. 201)

DCMC St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5476
(800) 325-3419

DCMC Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6170 (ext 231 or 229)

DCMC Chicago
ATTN: Greg Wynne
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021

DCMC Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381
(800) 722-8975 (ext 165)

DCMC Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloominton, MN 55425-1573
(612) 335-2003

DCMC Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
(316) 269-7137

DCMC Dallas
ATTN: Jerome W. Anderson
1200 Main St., Rm. 640
P.O. Box 50500
Dallas, TX 75202-4399
(214) 670-9205

DCMC San Antonio
ATTN: Thomas J. Bauml
615 E. Houston St.
P.O. Box 1040
San Antonio, TX 78294

DCMD EAST (DCMDE-DU)
ATTN: John T. McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(617) 753-3243
(617) 753-3174 (FAX)
E-Mail: bdu1078@dcrbab.dla.mil

DCMC Atlanta (DCMDE-GADU)
ATTN: Sandra Scanlan
805 Walker Street
Marietta, GA 30060-2789
(770) 590-6197
(770) 590-6551 (FAX)
E-Mail: sscanlan@dcmds.dla.mil

DCMC Lockheed Martin Marietta (LASC) DCMDE-RLA
ATTN: Erma A. Peacock
86 South Cobb Drive, Building B-2
Marietta, GA 30063-0260
(770) 494-2016
(770) 494-7883 (FAX)

DCMC Baltimore (DCMDE-GTDU)
ATTN: Gregory W. Prouty
200 Towsontown Blvd, West
Towson, MD 21204-5299
(410) 339-4809
(410) 339-4990 (FAX)
E-Mail: gprouty@balt8.dcmds.dla.mil

DCMC Birmingham (DCMDE-GLDU)
ATTN: Lola B. Alexander
Burger Phillips Center
1910 3rd Ave, N.
Suite 201
Birmingham, AL 35203-2376
(205) 716-7403
(205) 716-7836 (FAX)
E-Mail: lbalexander@dcmds.dla.mil

DCMC Boston, DCMDE-GFDU
ATTN: Philip R. Varney
495 Summer Street
Boston, MA 02210-2184
(617) 753-3467/4110
(617) 753-4005
E-Mail: pvarney@dcrb.dla.mil

DCMC Clearwater, North Florida DCMDE-GCDU
ATTN: Jim Masone
Gadsen Building, Suite 200
9549 Coger Blvd
St. Petersburg, FL 33702-2455
(813) 579-3015
(813) 579-3107 (FAX)

DCMC Cleveland, DCMDE-GZDU
ATTN: Herman G. Peaks
555 E 88th Street
Cleveland, OH 44199-2064
(216) 522-5446
(216) 522-6029 (FAX)
E-Mail: bgz9205@dcro.dla.mil

DCMC Dayton, DCMDE-GYDU
ATTN: Thomas E. Watkins
Gentile Station
1001 Hamilton Street
Dayton, OH 45444-5300
(513) 296-5150
(513) 296-5631 (FAX)
E-Mail: twatkins@dayton.dcro.dla.mil

DCMC Detroit, DCMDE-GJDU
ATTN: David C. Boyd
Warren, MI 48397-5000
(810) 574-4474
(810) 574-7552 (FAX)
E-Mail: dboyd@detroit.dcro.dla.mil

DCMD Grand Rapids, DCMDE-GMDU
ATTN: George Harrison
Riverview Center Building
678 Front Street, NW
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DoD Fast Track Guidance

This paper contains DoD's official guidance on what types of relationships between a small company and outside investors in the company qualify as an investment under the SBIR and STTR Fast Track ("Fast Track investment"). It includes specific examples of company-investor relationships that we have been asked about and our official responses on whether these relationships qualify as a Fast Track investment. If you have questions about whether a particular company-investor relationship qualifies, please contact the DoD SBIR/STTR Help Desk (tel. 800/382-4634, fax 800/462-4128, e-mail SBIRHELP@us.teltech.com). The Help Desk will refer any policy or substantive questions to appropriate DoD personnel for an official response.

I. General Guidance on What Qualifies As A "Fast Track Investment"

- The investor must be an **outside** investor, which may include such entities as another company, a venture capital firm, an individual "angel" investor, a non-SBIR/non-STTR government program, or any combination of the above. It does not include the owners of the small business, their family members, and/or "affiliates" of the small business, as defined in Title 13 of the *Code of Federal Regulations* (C.F.R.), Section 121.103. As discussed in that Section:
  - ⇒ Concerns are affiliates of each other when one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.
  - ⇒ [We] consider factors such as ownership, management, previous relationships with or ties to another concern, and contractual relationships, in determining whether affiliation exists.
  - ⇒ Individuals or firms that have identical or substantially identical business or economic interests, such as family members, persons with common investments, or firms that are economically dependent through contractual or other relationships, may be treated as one party with such interests aggregated.
- The **investment** must be an arrangement in which the outside party provides cash to the small company in return for such items as: equity; a share of royalties; rights in the technology; a percentage of profit; an advance purchase order for products resulting from the technology; or any combination of the above.

II. Specific examples of What Does and Does Not Qualify As a "Fast Track Investment"

A. Examples of What Qualifies as an "Outside" Investor

(1) Can a small company contribute its own internal funds to qualify for the Fast Track?

No. DoD is seeking outside validation of the commercial potential of the company's technology, and therefore requires that the funds come from an outside investor. Also, cash from an outside investor shows up plainly on the company's books and therefore can be more readily verified than a company's own matching contribution.

(2) Company A spins off company B, which wins a phase I SBIR award. Company A then wants to contribute matching funds to qualify company B for the Fast Track. Can A be considered an outside investor for purposes of the Fast Track?

In making our determination of whether company A is an outside investor, we would be guided by the definition of "affiliates" in 13 C.F.R. Sec. 121.103, discussed above. Our presumption is that in this example A and B would be considered "affiliates," and that A would therefore not be an outside investor for purposes of the Fast Track. However, that presumption could be rebutted by showing, for example, that the spin-off occurred several years ago and that A and B do not exercise control over one another, do not have common ownership or management, have different business interests, etc.

(3) Small company S wins a phase I SBIR award. The president of S is a major shareholder in another company Y, which wants to contribute matching funds to qualify S for the Fast Track. Can Y be considered an outside investor?

Our presumption is that Y would not be considered an outside investor. Our determination would be guided by whether the president's stake in Y is large enough that S and Y would be considered "affiliates" under 13 C.F.R. Sec. 121.103. Subsection © of Section 121.103 specifically discusses affiliation based on stock ownership:

c. Affiliation based on stock ownership.
   1. A person is an affiliate of a concern if the person owns or controls, or has the power to control 50 percent or more of its voting stock, or a block of stock which affords control because it is large compared to other outstanding blocks of stock.
   2. If two or more persons each owns, controls or has the power to control less than 50 percent of the voting stock of a concern, with minority holdings that are equal or approximately equal in size, but the aggregate of these minority holdings is large as compared with any other stock holding, each such person is presumed to be an affiliate of the concern.

If S and Y are found to be affiliates, we would determine that Y is not an outside investor.

(4) Does the outside investor have to be a single entity (e.g., a single venture capital firm) or can it be more than one entity (e.g., two angel investors and a venture capital firm)?

It can be more than one entity.

(5) Small company A contributes matching funds to small company B in order to qualify B for the Fast Track, and, at the same time, B contributes matching funds to A in order to qualify A for the Fast Track. Do A and B qualify as outside investors under the Fast Track?

No. A and B's relationship is such that their investment in each other would not provide outside validation of the commercial potential of their respective SBIR projects. We would therefore not consider them to be outside investors for purposes of the Fast Track.

(6) Can the brother of an employee of small company S contribute funds to qualify S for the Fast Track?

Probably not. Again, we would be guided by the definition of "affiliates" in 13 C.F.R. Sec. 121.103. The brother presumptively would be an affiliate of company S and not an outside investor.

(7) Venture capital firm V currently is a 22 percent shareholder in small company S. Can V invest additional funds in S to qualify S for the Fast Track?

Our presumption is yes. In making our determination, we would be guided by whether V and S are "affiliates," as defined in 13 C.F.R. Sec. 121.103. Section 121.103 provides (in subsection (b)(5)) that a venture capital firm is not affiliated with a company if the venture capital firm does not control the company -- e.g., by owning more than 50 percent of the stock of a small company (prior to its investment under the Fast Track), as described in 13 C.F.R. 107.865. 13 C.F.R. 107.865 can be viewed on the internet at http://www.acq.osd.mil/sadbu/sbir/affil2.htm.

(8) Large company L makes a cash investment in small company S, and then serves as a subcontractor to S on an SBIR project. Can L's investment in S count as a matching contribution for purposes of the Fast Track?

Only L's cash investment net of its subcontracting effort can count as matching funds for purposes of the Fast Track. For example, if L invests $750,000 in S and subcontracts with S for $250,000, only L's net contribution ($500,000) can count as matching funds for purposes of the Fast Track.

(9) Company Y makes a cash investment in small company S for purposes of the Fast Track, and also enters into a separate contract with S under which Y provides certain goods/services to S in return for $500,000. Can Y's cash investment in S count as a matching contribution for purposes of the Fast Track?

As in the previous example, only Y's cash investment net of the $500,000 it receives from S can count as matching funds for purposes of the Fast Track. However, if the separate contract between Y and S pre-dates S's submission of its phase I SBIR proposal, Y's entire cash investment can count as matching funds for purposes of the Fast Track.

(10) A group of investors wishes to invest funds in small company S to qualify S for the Fast Track. One of the investors is the mother of S's president, who wants to contribute $50,000 toward the effort. Can the group's investment in S count as a matching contribution to qualify S for the Fast Track?

The mother's investment of $50,000 does not count, because she is not an outside investor (see item (6) above). Contributions of the other investors can count provided that they meet the other conditions for the Fast Track (e.g., each must be an outside investor).

B. Examples of What Qualifies as an "Investment"

(1) Can a loan from an outside party qualify as an "investment" for purposes of the Fast Track?

No. The rationale behind the Fast Track is that an outside party is betting on the company's success in bringing the technology to market -- not just its ability to repay a loan.

(2) How about a loan that is convertible to equity?

A loan that is convertible to equity at the company's discretion would count as an investment under the following circumstances: (1) the loan is provided by a public entity (e.g., a state agency), or (2) the loan is provided by a private entity, and the SBIR company actually converts the loan to equity before the end of phase I.

(3) Can in-kind contributions from an outside investor count as matching funds under the Fast Track?

No. The matching contribution must be in cash. A cash contribution is a stronger signal of the outside investor's interest in the technology, and can be readily verified.

(4) Can a purchase order from an outside investor count as a matching contribution under the Fast Track?

An advance purchase order for new products resulting from the SBIR project can count as a matching contribution under the Fast Track (assuming the other Fast Track conditions are met).

(5) Can the funds raised from an initial public offering (IPO) count as matching funds for purposes of the Fast Track?

Yes, as long as the offering memo indicates that a portion of the funds from the IPO will pay for work (e.g., R&D, marketing, etc.) that is related to the SBIR project.

(6) If large company L pays small company S for work related to S's SBIR project and expects a deliverable (goods or services) from S in return, would that qualify as an "investment"?

No, for the same reason a loan does not count. Specifically, in this situation the large company is not betting on the small company's success in bringing the technology to market, but merely on its ability to provide the deliverable.

C. Examples Re: Timing/Logistics of the Fast Track Investment

(1) Can entity E's investment in small company S during the first month of S's phase I SBIR project count as a matching contribution to qualify S for the Fast Track?

Yes, provided that E is an outside investor and that the other Fast Track conditions are met. The investment can occur any time after the start of the phase I project.

(2) Small company A, which has won a phase I award, spins off small company B to commercialize the SBIR technology. A then convinces angel investor I to invest funds in B. Can I's investment in B count as a matching contribution to qualify A for the Fast Track?

For I's investment in B to qualify A for the Fast Track, DoD must determine that A and B are substantially the same entity, as evidenced, for example, by their meeting the definition of "affiliates" in 13 C.F.R. Sec.121.103. If DoD determines that A and B are substantially the same entity, I's investment in B could qualify A for the Fast Track. Of course, the parties must also meet the other conditions for the Fast Track (e.g., I must be an outside investor).

(3) Small company S is collaborating with a university on an STTR project. Investor I wishes to provide funds to the university in order to qualify S for the STTR Fast Track. Can I's investment in the university count as a matching contribution to qualify S for the Fast Track?

In order to qualify S for the STTR Fast Track, I's investment of funds must be in small company S, not in the university. S can then subcontract some of the funds to the university. The rationale is that a cash investment in the small company is a very strong indication of commercial potential, whereas an investment in the university is less so.

DoD's Critical Technologies
(Defense Technology Area)

1.	**Aerospace Propulsion and Power** -- technology directed toward propulsion and power systems for aircraft, missiles, and space vehicles in four major sub-areas: 1) gas-turbine propulsion systems for aircraft and cruise missiles; 2) propulsion systems for space and missile systems; 3) ramjet, scramjet, combined cycle propulsion systems for missile and space-launch systems and fuels; 4) non-propulsive power generation systems for aircraft, missiles, and space vehicles.
2.	**Air Vehicles/Space Vehicles** -- Air vehicles: technology of aeromechanics, flight controls, subsystem, air vehicle structures in fixed wing vehicles, rotary wing vehicles, unmanned air vehicles, and system integration technology. Space Vehicles: technology oriented toward the spacecraft bus, technologies unique to space and the military and their implementation through flight experiments in the following sub-areas: 1) thrust producing engines and devices for space launch, orbit transfer, and maneuver; 2) generation and distribution of electrical power on-board spacecraft; 3) thermal management for all satellite applications; 4) structures focused on adapting advanced materials and structures produced in basic research for space applications; 5) survivability focused on "environments" (both natural and hostile) and "techniques" (including active and passive approaches); 6) guidance, navigation, and control for the launch from earth, earth orbit and free space; 7) technology integration focused on adapting products of other technology areas to space systems; 8) flight experiments which focus on space qualification and transfer of technology to the military and civilian space communities.
3.	**Battlespace Environments** -- study, characterization, prediction, modeling, and simulation of the terrestrial, ocean, lower atmosphere, and space/upper atmosphere environments to understand their impact on personnel, platforms, sensors, and systems; enable the development of tactics and doctrine to exploit that understanding; and optimize the design of new systems.
4.	**Biomedical** -- yield superior technology in support of the DoD mission to provide health support to U.S. military forces by preserving the combatant's optimal mission capabilities and health despite battle and non-battle threats from military operations. Medical research programs must be conducted for the benefit of mankind and many are regulated by the U.S. Food and Drug Administration.
5.	**Chemical and Biological Defense** -- U.S. forces must be prepared for conflict in a chemical and biological environment in a Global Reach concept. The CB defense technology area includes four major subareas: 1) detection; 2) protection; 3) decontamination, and 4) information processing and dissemination.
6.	**Clothing, Textiles and Food** -- focuses on protecting and sustaining soldiers, sailors, airmen, and marines, individually and collectively. This technology includes two sub-areas: 1) Clothing and textiles - includes all textile-related polymer, fiber, yarn, fabric, film, dye, pigment, coating, and clothing systems and their packaging which enhance survivability, performance, and mobility. These efforts provide ballistic protection, percutaneous chemical/biological protection, countermeasures to sensors, integrated protection (flame/incendiary and anthropometric/biomechanical concepts), and bioengineered materials for protection. This subarea includes textile based technologies for items such as tentage and parachutes. 2) Food -- includes science and technological efforts to sustain warriors and enhance their mental and physical acuity and performance by nutritional performance enhancement, food preservation, food packaging, consumer acceptance, and equipment and energy technologies. This technology area supports the unique feeding requirements of the military services ranging from general purpose individual rations to group ration systems for special operations.

7.	**Command, Control and Communications (C3)** -- area encompasses C3 systems of all types: data processing hardware and software dedicated to operational planning, monitoring or assessment (including information fusion), distributed processing, distributed data storage, and distributed data management. **NOT INCLUDED:** general purpose computer hardware and high performance computers, general purpose software, languages, software engineering, environments, and communications and processing elements considered subsystems in vehicles.
8.	**Computing and Software** -- push the frontiers of advanced information technology beyond that normally achieved by the commercial sector alone, to enable creation of broad range advanced information processing systems of critical value in support of the missions of the DoD. This area is separated into six broad subareas: 1) system software; 2) software and systems development; 3) intelligent systems; 4) user interface; 5) computing systems and architecture; and 6) networking.
9.	**Conventional Weapons** -- develop conventional armament technologies for all new and upgraded non-nuclear weapons which includes efforts directed specifically toward non-nuclear munitions, their components, and launching systems, guns, bombs, guided missiles, projectiles, special warfare munitions, EOD devices, mortars, mines, countermine systems, torpedoes, and underwater weapons and their associated combat control. There are six major sub-areas: 1) fuzing/safe & arm; 2) guidance and control; 3) guns; 4) countermine/mines; 5) warheads and explosives; and 6) weapon lethality/vulnerability.
10.	**Electronics** -- extends from basic research to applications at the subsystem level. The electronics technology area includes research, development, design, fabrication, and testing of electronic materials; electronic devices, including digital, analog, microwave, optoelectronic, vacuum and integrated circuits; and electronic modules, assemblies, and subsystems organized into five sub-areas: 1) RF components; 2) electro-optics; 3) microelectronics; 4) electronic materials; and 5) electronic models and subsystems.
11.	**Electronic Warfare/Directed Energy Weapons** -- <u>Electronic Warfare:</u> Develop technology for the offensive and defensive application of EW which includes efforts in intercept, counter, and exploit the complex threat weapons spanning the entire electromagnetic spectrum, including radio frequency (RF), infrared (IR), electro-optic (EO), ultraviolet (UV), and multispectral/multimode sensors. Electronic Warfare is divided in three subareas: 1) force protection; 2) Offensive EW; and 3) EW support functions. <u>Directed Energy Weapons:</u> Technologies relate to the production and projection of a beam of concentrated electromagnetic energy or atomic/subatomic particles. The DEW technology is divided into three sub-areas: 1) laser weapons; 2) RF weapons; and 3) particle beam weapons.
12.	**Environmental Quality/Civil Engineering** -- <u>Environmental Quality:</u> technologies which reduce the costs of DoD operations while ensuring mission accomplishment is not jeopardized by adverse environmental impacts. There are four sub-areas: 1) cleanup of contaminated sites resulting from DoD operations; 2) compliance with laws concerning the treatment and disposal of hazardous waste products; 3) pollution prevention; 4) conservation of natural and cultural resources. <u>Civil Engineering:</u> technology efforts to solve critical DoD civil engineering problems related to training, mobilizing, deploying, and employing a force at any location at any time. This technology area includes survivability and protective structures, airfields and pavements, conventional facilities, critical airbase facilities and recovery, ocean and waterfront facilities and operations, sustainment engineering, and fire fighting.
13.	**Human Systems Interface** -- technology fully leverages and extends the capabilities of warfighters and maintainers to ensure that fielded systems will exploit the fullest potential of the warfighting team, irrespective of gender, mission or environment. This technology is organized into four areas: 1) crew systems integration and protection; 2) performance aiding; 3) information management and display; and 4) performance assessment and design methodologies.

14.	**Manpower, Personnel and Training** -- Manpower and personnel technology addresses the recruitment, selection, classification, and assignment of people to military jobs. It seeks to reduce the attrition of high-quality personnel and helps the senior department leadership to predict and measure the consequences of policy decisions. Training systems technology improves the effectiveness of DoD's investment in training instruction, improves the efficiency of student flow through the training pipeline, enhances military training systems, provides opportunities for skill practice and mission rehearsal, and lowers life-cycle costs of training systems and combat systems.
15.	**Materials, Processes and Structures** -- technologies produce an enabling array of capabilities for every DoD system that flies in air or space, navigates on land or over/under the sea, and fires or is fired upon. MP&S spans all material categories -- metal and intermetallic alloys; ceramics; polymers; composites of all types; semiconductors; superconductors, optical, ferroelectric, and magnetic materials; and materials for power sources.
16.	**Sensors** -- technologies are divided into five major sub-areas: 1) radar sensors; 2) electro-Optic sensors; 3) acoustic sensors; 4) automatic target recognition; and 5) integrated platform electronics and sensors. Applications include strategic and tactical surveillance, identification and targeting of threats from all military platforms including satellites, aircraft, helicopters, ships, submarines, ground vehicles and sites, unmanned air vehicles, unattended ground sensors and the individual soldier.
17.	**Surface/Under Surface Vehicles/Ground Vehicles** -- Surface/Under surface vehicles: technology for improved combat efficiency, survivability, and stealth of surface ships, submarines and unmanned undersea vehicles. Ground vehicles: technologies to support the basic Army and Marine Corps land combat functions: shoot, move, communicate, survive and sustain. Covered here are propulsion and power, track and suspension, vehicle subsystems, hydrodynamics, signature reduction, fuels and lubricants and integration technologies related to land combat vehicles, including amphibious vehicles with a ground combat role.
18.	**Manufacturing Sciences and Technology (MS&T)** -- area is focused on cross-cutting engineering and manufacturing process technologies beyond those developed in conjunction with new product technologies in the other technology areas. Includes ARPA 6.2 and 6.3 programs in information technology for manufacturing applications, Service/DLA manufacturing technology (ManTech) programs, advanced technology demonstrations for affordability, and advanced industrial practices to demonstrate the combination of improved process technology and improved business practices. These programs encompass process technologies at all manufacturing levels (enterprise/factory/cell/machine/unit process).
19.	**Modeling and Simulation (M&S)** -- includes development, integration, and implementation of tools and applications to apply M&S more broadly and with greater validity across DoD. Directly dependent on enabling technologies such as high speed computing, communications and networking, human systems interfaces, and software. Major sub-areas are: 1) architectures (software, data/database methodologies, and interfaces with communications and networks); 2) environmental representations (terrain, weather, atmosphere, space, oceans, and others); and 3) computer generated forces (systems representations, human behaviors, and their interactions).

Note: The above information is a summary of the information contained in documents "Defense Technology Plan" (DTIC # A285415) and "Defense Science and Technology Strategy" (DTIC # A285414).

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